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THE
INTERNATIONAL ASSOCIATION
OF
MEDICAL MUSEUMS

BULLETIN NO. VI. - VIII

EDITED BY

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The International Association of Medical Museums

BULLETIN NO. VI.

EDITED BY

S. WARTHIN, M.D., and M. E. ABBOTT, M.D.,
Ann Arbor, Michigan, and Montreal, Canada.

EDITORIALS

THE AMERICAN SECTION OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS IN THE EUROPEAN WAR.

As was pointed out in our last Bulletin, the general rupture of international relations that exists today, as a result of the widespread ramifications of the present War, involves the complete cessation of the activities of international societies. To this statement this Association has proved itself no exception. Its international correspondence and all exchange of intercourse between the nations composing its membership have ceased entirely.

Fortunately, however, for the interests and future of this Association, its internal organization had proceeded, before the outbreak of the War, to the point of the formation of Local and National Sections in the various countries of its membership, as integral units so organized as to be capable of carrying on their own activities independently of the international body. This was done at the last international meeting in August, 1913.

Probably the only Local Section sufficiently advanced in its autonomy at the present time to maintain such independent activity is the Local American Section. It has the further advantages of being situated in countries remote from the seat of War and therefore less disorganized by its havoc; and of numbering among its members the International Secretary who is empowered to pro-

ceed with the publication of the Bulletin from the income of the Strathcona Fund, so that its columns remain accessible to the proceedings of this Section independently of the accidents of war. These circumstances explain also the fact that the present Bulletin is entirely devoted to the Proceedings of the Local American Section.

The Officers of this Section have realized their responsibility, and that the maintenance of their own activity at the present juncture may mean the holding intact of the international organization which might otherwise disintegrate. That this is the case is best shown by the standard of the present Bulletin.

The present is a time of heart-searching, if such has ever been in the world's history, when the serious-minded in every community are asking themselves how they can best take their part, whether it be that of neutrals or of combatants, in ameliorating the results of, or in bringing to a right issue, the great struggle of our time. The loyal support given by its members of the American Section during the two difficult years that are just past, have crystallized its importance, and have established it as one of the recognized ancillary Medical Societies of this Continent. In the uncertain future, when peace may be at last restored, one cannot tell what threads of renewed international amity may not be bound by the solidarity which this Section has achieved, and, which is likely to be the basis of the reactivation of the parent international organization.

ON THE ORGANIZATION OF THE SOUTH AMERICAN SECTION.

The appointment of Professor R. M. Pearce, President of the American Section of this Association during the past three years, as chairman of a commission sent last January, by the Rockefeller Foundation (International Health Commission), to make a medical survey of Southern Brazil, led to the hope that the suspension of the international activities of the Association produced by the War might be utilized in extending the work of the Association in the countries of South America, where, owing to the large amount of tropical material available, and the dearth of those lesions common in more northerly countries, the establishment of an international system of exchange would be of the highest value to all concerned. With this thought in mind, Professor Pearce undertook to enquire, during his stay in Brazil, into the possibilities of extended organization, and into the feasi-

bility of holding the next international meeting there, in view of the fact that a meeting, in conjunction with the International Congress of Medicine, is inevitably and indefinitely postponed.

It was found, however, that the time for such a Congress in South America—or at least in Brazil, the only country visited—is not yet. Brazil, with other South American countries, is feeling the effects of the war to a very serious extent, and the museum interest,—except in one or two large centers—is not a paramount one at the present time. The immediate function of the American Section (which it is to be remembered includes the Canadian members) seems to lie not in extension, but in the steady evolution of this branch of the Society here, where, in spite of all difficulties, favorable conditions still exist. It is only by keeping the machinery of this Section active and intact, that we may hope, when the War is over and a just peace shall at last have been proclaimed, again to forge links that will be lasting in an international system of exchange.

MUSEUM GLASS-WARE.

It seems a far cry to state that the museums of America have been sorely affected through the European War. Such, however, is the case and if some relief is not soon forthcoming the work of the medical museums will virtually come to a standstill. Even at present there are many museums which are unable to perform properly their work of preparing and mounting their specimens because of the want of museum jars. Heretofore, Germany has supplied almost the entire demand for museum jars. The glass works of that country have cooperated with the desires of their consumers in supplying the varieties of shape and size as the different museums found most suitable for their needs. By this cooperation they have had on the market several hundred types and sizes giving a selection for even the most fastidious. Moreover, it has been possible for college museums to import this ware duty free. The prices thus offered were most reasonable and save for the delay in shipment, no criticism could be offered.

Today, however, we are placed in the position of having no other source from which this necessary article can be obtained. True it is that preparation is under way to have this glass-ware manufactured in Great Britain. Difficulties of importation are at the present time great and in how far the supply and character of this glass-ware will meet with our approval cannot be stated. With the large demand for museum jars in America and with

the great development of glass manufacture in this country, there seems to be no reason why a cooperation between the Museum Association and the glass manufacturers cannot be obtained.

Up to the present the glass manufacturers have feared to enter the field of competition with the low duty free prices from abroad. At the recent meeting of the American Section of the International Association of Medical Museums a full discussion upon the matter was taken up and it was indicated that if the Association could have its members buy all their necessary glassware from one source that it might be possible to interest a manufacturer to take up the problem. A committee was appointed to look into the matter to have, if possible, the manufacture of American museum jars undertaken. Since this meeting it has been found that the American glass companies are interested in our problem and several of them have stated their willingness to enter the field of manufacture. As, however, the molds necessary for the work are expensive the companies desire to manufacture the minimum number of sizes (probably ten) upon which trial will be made. Should the work prove successful, new molds may rapidly be added to the number. The members of the Association must, therefore, not be disappointed if the sizes of the initial group of jars do not meet with all of their desires. The sizes which will be selected will accommodate the common organs which are preserved in museum collections.

Up to the present no definite arrangements have been entered into, in that the standard of sizes has, as yet, not been adopted. At a subsequent date a notice will be sent to the members of what has been accomplished.

THE MUSEUM OF THE JEFFERSON MEDICAL COLLEGE.

The leading article is by a member of this Association whose ingenuity in details of Museum equipment, and skill in matters of Museum technique, are well known to us all. Dr. Coplin was among the first on this Continent to apply successfully the Kaiserling method and to publish his results.¹ And ever since then, both out of the resources of his own well-equipped work-shop and through co-operation with intelligent manufacturers, he has presented us from time to time with methods or practical contrivances, many of which are inventions of no small value. The

¹ Journ. Amer. Med. Assoc. Aug. 13th, 1904.

technical hints given by him in the article published here are so useful that we have reproduced many of the illustrations. We would recommend especially his steel label holders, which are a solution of a real difficulty and which have been adopted with great satisfaction in the Medical Museums of McGill and St. Louis Universities, and his Museum Display Refrigerator, which is admirably adapted for the thorough carrying out of an objective teaching method of almost universal application.

The article as a whole is to be welcomed as a somewhat new departure, which sets the Medical Museum in its rightful place as a teaching medium of the highest value, and imparts to the workers in it the stimulus of an acknowledged ideal, and which, incidentally, sheds light upon the excellent system and arrangement carried out in the Museum of the Jefferson Medical School.

It is for this latter reason also that it is republished here. The suggestion has been made that a certain amount of space should be devoted in each succeeding Bulletin to describing and illustrating the various leading Medical Museums. The publication of Dr. Coplin's excellent descriptive article, based upon the Museum under his care, may well lead the way in this particular.

OBITUARY

JOSEPH HENRY HEWITT.

Dr. Joseph Henry Hewitt was born at Elizabeth City, N. C., July 17th, 1877. He received his A.B. degree from the University of North Carolina in 1899 and his M.D. from the Johns Hopkins University in 1906. He then did work in medicine at Harvard University and certain research studies at the Marine Hospital at Woods Hole, Mass. In 1907 and 1908 he occupied the post of resident pathologist in Cleveland at St. Vincent's and the Lakeside Hospital respectively. In 1909 he was demonstrator in pathology at the University of Minnesota, and in 1910 pathologist at the State Institution, Georgia, studying Pellagra and the Hook Worm. In 1911 he was pathologist at the Children's Hospital and St. Joseph's Hospital in Chicago, and in 1912 and 1913 Professor of Pathology at the Baylor University, Dallas, Texas. In 1914 and 1915 he became pathologist to the City Hospital at Cleveland. During the year 1915 he spent three months at Saranac Lake, N. Y., having contracted tuberculosis, from which he died after an abdominal operation at Johns Hopkins Hospital, Baltimore, January 10th, 1916. Dr. Hewitt was elected an Active Member of this Association in the year 1910.



JOSEPH HENRY HEWITT, A.B., M.D.

JULY 17, 1877—JANUARY 10, 1916.

ORIGINAL COMMUNICATIONS

General Articles

MEDICAL MUSEUMS.¹

W. M. L. COPLIN, M.D.

A TEACHING MUSEUM.

"A museum is an encyclopedia in which things, rather than pictures of things, are assembled for purposes of instruction."²

"The true functions of our medical museums, in addition to providing for public instruction, should be to afford facilities for a course of instruction which will give medical students the opportunity to personally observe facts, and the impressions which will follow will be clear, definite, permanent, and hence far more valuable than any plagiarized information taken from books."³

"It is in the presentation of a series of specimens in an ordered sequence that the strength of the museum system lies."⁴

"The conclusive evidence of lack of educational conscience or pride is the general absence of a decent museum."⁵

¹The following paper comprises a collection and more or less sequential presentation of data reported before the American Section of the International Association of Medical Museums, at various meetings in the last few years and before other societies, and published in the Publications of Jefferson Medical College and Hospital, Vol. VI.

²W. J. Holland, Ph.D., LL.D., Penn. Med. Jour., Oct., 1914.

³M. Josiah Roberts, quoted by Dr. Abbott, cited below.

⁴Maude E. Abbott, B.A., M.D., Jour. Amer. Med. Assoc., March 25, 1905, p. 936.

⁵Abraham Flexner, The Carnegie Foundation for the Advancement of Teaching, Medical Education in the United States and Canada, 1910, p. 82. The sentence quoted is a comment on the absence of proper equipment in some medical colleges.

"L'anatomie pathologique est le guide qui doit éclairer le médecin ou le chirurgien au lit du malade."⁶

"The ideal pathological museum must be in a teaching institution, and must be primarily organized for teaching purposes."⁷

A medical visitor to Great Britain and the continent must be impressed when he enters any one of several museums of institutions devoted, in whole or in part, to training graduate or undergraduate students of medicine. On the part of those whose lives have been spent in the study of subjects portrayed, casual visits afford opportunity for observation and reflection; moments given to walks among the collections are profitable and hours or days thus spent are of inestimable value. Notwithstanding the fact that every observing professional rover apprehends their worth, we in America have been deplorably slow in acquiring and properly disposing collections in the least comparable to some of those seen abroad. The Library of the Surgeon General's office has far outstripped the associated Army Medical Museum and nowhere on this continent has a medical museum of recognized superiority been produced. I know of but one museum intended for the use of students of medicine, that in conception and accomplishment approaches the standard I have in mind—it richly merits mention—the Medical Museums of McGill University. More general museums of broad scope, such as those of natural history and archeology abound but a medical museum above criticism is as yet unattained. Even in medical colleges the museum is usually relegated to a position entirely inferior to that which its importance merits. Straggling dissociated collections, so-called department museums, are as a rule makeshifts and of restricted value. Some of these partake of the nature of trophies, and are collected by an operator much as a hunter adorns his quarters with fur rugs and stuffed heads. Specimens that a student sees once during his course, often in a busy teaching hour, must be obtrusively gross or conspicuously impressive to secure more than passing notice and it is just such specimens that are often most misleading and truly least instructive. Tumors of enormous size have no more teaching value than skeletons of giants. The usual is necessary; the uncommon frequently leads to erroneous impressions.

⁶ Houel, *Manual d'Anatomie Path.*, Paris, 1862.

⁷ Prof. H. E. Robertson, *Internat. Assoc. Med. Museums*, Bull. IV, p. 12.

MUSEUM TEACHING.

Occasionally a teacher of pathology tells me he uses fresh material and needs no museum. The plan is ideal but in every instance is absolutely impracticable. A thousand postmortems and the largest operating service even when combined could not supply adequate material. The essential orderly sequence necessary to an illuminating presentation is rendered possible by a grouped collection properly arranged and by no other means. All usual anatomical phases of pulmonary tuberculosis can be apprehended by a student when brought in actual contact with a properly prepared, advantageously posed and displayed and sequentially arranged group of specimens; the dysenteries, endocarditis and its results, repair of bone and many other processes yield themselves to systematized exhibition. Dissociated facts elicited at post-mortems or revealed at operations, in either case often separated by days, weeks or months, are not systematized by the beginner; systematize them for him and he grasps the important features with surprising speed. We learn to read by the use of orderly arranged words and not from the detached, accurate definitions contained in a lexicon. If adequately presented in a museum or morbid anatomy collection the tale recorded in altered organs is quickly comprehended by average pupils. In some instances a few organs suffice, in others, for example fractures of bones, hundreds of specimens are necessary. Collections for teaching morbid anatomy are often accessible to the student during a brief teaching period only; he cannot return to them and refresh his memory, clear up doubtful points and correct erroneous impressions; for these purposes specimens must be constantly accessible.

The scope of museum teaching and the special and general uses of museums in connection with medical colleges have been so fully set forth by Dr. Abbott in her article, to which reference has already been made,⁴ ⁵ that here they may be omitted. The system of classification mentioned by Dr. Abbott and more fully detailed in a later publication⁶ at first appears cumbersome and unwieldy but experience shows that it has been well thought out and that it may be used to advantage and without confusion. Such modification as we have found convenient has been determined by some peculiarity of our conditions and probably possesses no real advantage.

⁴ See also Dr. J. Kaufman, *Internat. Assoc. Med. Museums*, Bull. IV, p. 9. Dr. Abbott, a note only, in same number, p. 72.

⁵ Maude E. Abbott, B.A., M.D., *Internat. Assoc. Med. Museums*, Bull. IV, p. 23.

Dr. Abbott's observation, quoted at the beginning of this article, that "It is in the presentation of a series of specimens, in an ordered sequence that the strength of the museum system lies" is a crystallized fact. In many instances no other method approaches it. There should also be set forth the inestimable value of presenting the matter to vision rather than to the ear alone. Certainly all obtainable in any natural history museum may be secured in printed form but does any one believe that, by unaided reading, the same impression is ever conveyed, or facts in natural history ever adequately so presented? Pictures help, atlases have their uses but neither one nor both can replace specimens. The best of all teaching is by that method affording opportunity to see the object concerning which we wish the student to acquire accurate knowledge.

We are evolving a system, not yet fully perfected, which contemplates the following:

I. ILLUSTRATING LECTURES.—Any member of the teaching corps giving instruction regularly provided in the curriculum, fills out and sends to the Curator the following blank:

JEFFERSON MEDICAL COLLEGE
MUSEUM
APPLICATIONS FOR SPECIMENS

Date,.....

It is my intention to lecture on

.....
(here mention subject)

on	at.....	A.M.	{ Upper Amphitheater Lower Amphitheater East Lecture Room West Lecture Room Clinic }	{ Cancel Four Lines }
(date)	(hour)	P.M.		

(Note.—The work will be greatly facilitated if the professor or a delegated assistant visits the Museum and indicates in this application, preferably by number, the particular specimens which he desires. The Curator will be aided in complying with a general request by any detailed instruction which may be appended.)

I desire specimens as follows:—

.....
.....
.....
.....

(Signed).....

The following regulations have been approved by the Faculty:—

For a lecture occurring before 2 P. M. this blank, properly filled out, must be delivered to the Curator not later than 5 P. M. on the preceding day; for a lecture occurring after 3 P. M. it must be presented before 2 P. M. on the day on which the lecture is given.

All specimens must be returned to the Museum immediately at the close of the lecture.

While in the lecture room teachers are responsible for any damage to specimens. During transportation the janitor is responsible; in the Museum the Curator is responsible.

Please note condition of specimens when received by you and when turned over by you to the janitor.

In case of injury to or loss of any specimen by a student or class please notify the Director at once, giving name of student or of class responsible.

Classes may be told to visit the Museum and examine any specimen; the Curator, during his hours in the Museum, will afford any assistance possible.

MUSEUM HOURS

MORNING: 8:30 TO 11:30; AFTERNOON 12:30 TO 6, JANITOR ON CALL.
CURATOR IN ATTENDANCE FROM 2 TO 6 P. M.

Copies of this blank may be obtained from Clerk in College Office
or from Curator.

Back of blank contains space upon which the Curator enters name of lecturer, subject and list of specimens supplied. Properly folded the blank fits a 3 by 5-in. index file and may be kept for future reference. With specimens are sent photographs and colored plates in photographic printing frames. We hope to render it possible later to supply lantern slides and charts; at present these are departmental, not the property of the museum, and the staff is too small properly to conserve and handle them.

Upon return of specimens they are placed on an open demonstration stand (Fig. 9), or case where the student may inspect them at his convenience, and where they remain until replaced by another group.

2. A room immediately adjacent to the museum is devoted to morbid anatomy. Here any department may bring groups or sections of the class for demonstration of fresh or museum material. At present this is used by the Department of Pathology alone but we hope to see other departments also avail themselves of this facility.

3. EXHIBITION REFRIGERATOR.—Details of museum refrigerator are given on p. 21. All fresh material coming from

autopsy or operation is exhibited from day to day and may be inspected at any time during museum hours. This has proven a most attractive feature; a list of specimens on exhibition is kept posted in the library. Students often desire to look over operation material. Crushed limbs, specimens of gangrene, organs from cases of poisoning, etc., are often most instructive.

4. In the morbid anatomy course museum material is freely used and in addition the students are given numerous wet specimens illustrating many commoner affections. Such material they handle as they do fresh specimens; it wears out and must be replaced frequently.

5. We are developing collections suited to case teaching. These include clinical history kept in accession file, autopsy protocol and all specimens of interest from any particular case.

6. The museum is open from 8.30 A.M. to 6 P.M. daily; from 8.30 to 11.30 A.M., and from 12.30 to 2.30 P.M. a preparator is in attendance. From 2.30 to 6 P.M. the Curator is also in the museum or adjacent morbid anatomy room. Nothing has been lost nor during a period of three years have those using the museum for study broken a jar or injured a specimen. By breakage we have lost some, not much, in lecture room or laboratory or during transportation, but the total is negligible.

7. We need a descriptive catalogue. We strive to make our labels descriptive. But something more is needed; I shall not call it a catalogue but rather a museum syllabus.

8. As a part of laboratory instruction. No course in normal or morbid histology is complete unless closely connected with a study of gross specimens. In ward classes, classes in toxicology, fracture dressing, sections in obstetrics (malformations, hydrocephalus, etc.) and in all general section teaching museum material is most stimulating.

9. I hope to see a museum of instruments and appliances used in diagnosis and treatment. In this line we have not much but I trust time will show continued growth. A sanitary section would be most useful. Prof. Robertson and Prof. Terry have suggested affording selected groups of laymen opportunities to use medical museums or parts thereof.

THE MUSEUM.

Few medical colleges possess a room suited to museum purposes. It should have a skylight; even with large windows side lights are not satisfactory. Many museums in London, Edinburgh, Glasgow and on the continent, have solved the lighting by

the use of large skylights and broad balconies. This plan has proven very satisfactory in our museum.

Another point of great value is to have the museum so located that students find it convenient and constantly accessible. To reach one of our lecture rooms, used daily, largely by the senior class, those attending the lecture must pass the museum doors. The laboratory of morbid anatomy is immediately adjacent and that of morbid histology is on the same floor; bacteriology and hygiene are on the floor above; two laboratories and one lecture room are on the floor below. It would be advantageous to have museum, library and reading-room brought closely together, possibly in one room with alcoves, or at least in contiguous rooms. The plan would make for economy of administration and the usual systemization of libraries could, with advantage, be applied to museums. Many things contained in libraries, for example, atlases, could, in an illuminating manner, be displayed in the museum. Medals, old instruments, old books, etc., would add to the interest. A trained librarian should make an accomplished curator, or at least a discriminating expert at cataloging.

The acquisition of an acceptable museum is tedious, time-consuming and fraught with the dreariest drudgery, but once possessed, even in a small way, properly organized and systematically used, its value is deeply appreciated by both teacher and student. For more than half a century the museum of The Jefferson Medical College had grown by small accretions, larger gifts and by bequests. Museums develop slowly and are never fully grown; properly managed they should not grow old. For years a room in which the collections were stored constituted "the museum." Students rarely entered it and probably never truly studied any contained material or group of specimens. In 1899 an attempt was made to better previous conditions but as no trained assistance was provided and no one made specifically responsible practically nothing was accomplished. In 1912, after removal of the department of anatomy to the Daniel Baugh Institute of Anatomy and Biology, space became available and a real museum was started. In the old dissecting room extending through two stories, an enclosing balcony was provided. In erecting the balcony we considered how least to detract from the excellent skylighting of the main floor. After considerable study it was decided to construct the balcony floor of vault light glass, steel and reinforced concrete; the result has given entire satisfaction. The appearance is shown in Fig. 2. The main floor affords 2,548 sq. ft. and the balcony 1,781 sq. ft., a total of 4,329 sq. ft. The space available

is not fully adequate but we could give no more. Part of the collection is housed in an adjoining room and other space is available for general storage, preparation rooms, etc.

New cases were devised and the work of installation started; it crept at snail's pace but has, in part at least, gradually evolved into a teaching museum of real value. The accompanying illustrations and the following description are intended to give the reader some idea of the equipment and general arrangement; newer ideas and improved methods are presented with some detail.

MUSEUM REFRIGERATOR.

From postmortems and operating rooms we receive considerable material much of it possessing an ephemeral teaching value, but not worth the expense or trouble incident to permanent preservation. Many specimens are mutilated during removal and while in the fresh state they show much of value that cannot be satisfactorily preserved. In other instances the museum collection contains better examples but the fresh specimen should be shown; this applies to several conditions but notably to gangrene of which many specimens are seen annually, and all cannot be preserved. Pulmonary tuberculosis includes another productive group. In addition to the value of refrigeration under conditions mentioned there is one factor of the greatest importance which quite escaped me when I first thought of the installation. However attractive a museum collection, no matter how complete some series may be, the student feels that he dare procrastinate and that a visit tomorrow will be just as good and for the moment at least, he fancies will be more convenient. Setting out groups for study, a series illustrating lectures being given, helps, but fresh material proves a most important attraction. A section of the class, usually twelve to twenty-four students, sees an operation or an autopsy and examines the specimens. These men talk to room-mates, companions and friends, or discuss the matter with members of other sections so that when the customary notice is posted in the library many members of the class flock to the museum and line up in front of the refrigerator; others look in the door, see available viewing space filled, mentally note the fact and make their visits later or on the next day. Once in the museum the student wanders around the room, often inspecting several cases and frequently examining mounted specimens illustrating the same or allied conditions.

For display through the observation windows careful assembling of material and well-chosen arrangement renders ex-

hibits more attractive and, what is more important, also increases the teaching value. We use rectangular monel metal pans 15 in. long by 12 in. wide, or 12 in. long by 12 in. wide and in both sizes 2½ in. deep; blocks of cork 10 in. square and 1½ in. thick are kept on hand. A cork slab is put in a pan of appropriate size; over the cork is laid a pad of gauze saturated with normal saline, which should be boiled, and on the gauze are placed two thicknesses of some inexpensive bibulous paper, *e.g.*, a cheap gray filter paper, necessary to prevent gauze threads from marking the specimen; cotton may be used but is not so good. Gauze may be washed, sterilized by boiling or in formalin (first Kaiserling), and used repeatedly. Saline solution or water is kept on bottom of pan. A split-pin is placed at the top of the block and in this a brief label is inserted. Split-pins at the side may be supplied with label and wire or thread leaders to points on the specimen to which it is desired to call particular attention. In this manner a most comprehensive descriptive legend may be appended. (See Fig. 4.) After approved posing the specimen is placed beneath a window in the box and a typewritten copy of the case history or an acceptable abstract thereof is placed in a photographic printing frame and suspended above; with this may also be exhibited an abstract of the operation or postmortem finding (see Figs 1 and 3).

The refrigeration apparatus is compact and simple; the janitor has operated it for two years; occasionally our engineer visits, inspects and oils the plant. We keep a "log" showing the run every day. This is filled in by the janitor; any noteworthy variation results in an inquiry as to the cause. If the box is well filled the temperature is more readily maintained, the specimens acting as absorbing bodies become auxiliary to the tank of calcium chloride solution. Constancy of temperature is materially influenced by frequent or prolonged opening of refrigerator doors. With regard to the expense of running we now possess fairly accurate information. The outside temperature makes much less difference than I had anticipated; of course this is an evidence of good insulation. The refrigerator is usually shut down early in June and started about the first of October; as the museum is practically always comfortably heated there is little difference between summer and winter refrigeration. For comparison I append table (p. 22) from "log" showing results for 14 days, seven in June, 1914, and seven in January, 1915:

Superior insulation reduces the average loss, even in use with necessary opening of doors, to about 7° in 24 hours. The run-

ning time necessary to maintain a temperature between 0°C. and 5°C. is influenced by the care with which the expansion valve is controlled and no doubt with a more experienced or more skilled attendant the expense would be less; however, the increased salary necessary to secure higher skill would be much greater than the resulting economy in current.

The equipment comprises a ½-ton York compressor operated by 1¼-hp. electric motor both installed by the York Manufacturing Company. We have had some trouble with the expansion valve which is of a type no longer supplied; the work has been satisfactorily done.

The operation is inexpensive; the usual run is about 2½ to 3½ hours daily, the average a trifle over three hours and the cost just under five cents per hour's run, five-eighths of a cent per hour

OPERATION OF REFRIGERATOR, SEE TEXT, p. 21.

Date	Machine started	Temperature on starting, degrees	Machine shut down	Temperature after stopping, degrees	Run in hours	Temperature fall, degrees
1914						
*June 5	7.15 A.M.	+ 9.0	11.00 A.M.	+ 2.0	3¾	7.0
June 6	7.30 A.M.	+ 9.0	10.30 A.M.	+ 3.0	3	6.0
June 7	2.30 P.M.	+ 12.0	5.00 P.M.	+ 6.5	2½	5.5
June 8	7.30 A.M.	+ 12.0	11.00 A.M.	+ 5.0	3½	7.0
June 9	11.30 A.M.	+ 13.0	11.15 A.M.	+ 5.5	3¾	7.5
June 10	7.30 A.M.	+ 12.0	11.15 A.M.	+ 4.5	3¾	7.5
June 11	7.30 A.M.	+ 11.0	11.00 A.M.	+ 6.5	3½	6.5
1915						
†Jan. 5	1.00 P.M.	+ 10.2	5.30 P.M.	+ 2.4	4¼	7.8
Jan. 6	7.30 A.M.	+ 7.3	10.30 A.M.	+ 3.7	3	3.6
Jan. 7	7.00 A.M.	+ 10.2	10.30 A.M.	+ 3.2	3½	7.0
Jan. 8	7.15 A.M.	+ 10.0	10.45 A.M.	+ 2.9	3½	7.1
Jan. 9	7.30 A.M.	+ 9.0	11.45 A.M.	+ 1.7	4¼	7.3
Jan. 10	1.45 P.M.	+ 9.6	2.30 P.M.	+ 7.8	¾	1.8
Jan. 11	7.15 A.M.	+ 12.0	11.00 A.M.	+ 3.2	3¾	8.8

* Mean outside temperature for the week, 22.3°C.

† Mean outside temperature for the week, 4.0°C.

for 24 hours' refrigeration. The temperature maintained should rarely fall below $2^{\circ}\text{C}.$, about $5^{\circ}\text{C}.$ is better; $10^{\circ}\text{C}.$ is too high but for a few hours no harm results. At first we erred in running the temperature too low—continuously below $0^{\circ}\text{C}.$; in fact I thought such a temperature necessary or at least desirable; we learned that freezing injured many specimens containing much blood or other fluids—these froze easiest—and, what was worse, dried them so rapidly that many were ruined before we determined the cause. The refrigerator is copper lined; formalin in Petri dishes is kept in the box to prevent bacterial growth and as a special precaution against moulds although we have not been bothered by either even when specimens such as gangrenous limbs have been on exhibition for three weeks. As a matter of fact a limb giving off a most offensive odor accompanying senile gangrene was practically odorless when removed from the box.

On one occasion when visiting the museum Prof. McFarland said he had often wished it were possible to freeze a specimen posed as desired with the hope that while frozen it might be placed in the fixing solution and fixation secured before thawing. By the use of a very cold fixing solution a thoroughly frozen specimen or one little more than chilled may, if it is thick and bulky, be prepared in this manner. The best result will be obtained if the frozen specimen is immersed in cold Kaiserling and the container left 24 hours in the refrigerator. The method is of most value when the specimen is composed largely of fat, for example a very fat mamma; by any other method the tendency to float requires some sinking device and this not infrequently results in distortion.

I had feared that the glasses used in the observation windows would sweat, but, even in the most humid weather we have had no condensation worthy of note. On the inner panes of glass visible sweating has never occurred; once or twice when the museum was relatively warm and the humidity exceptionally high the outer glass has obscured slightly; in nearly three years this has occurred not over five times and has never been so profuse that it could not be easily prevented from interfering with observation by the occasional use of a towel left suspended near by.

The refrigerator is so constructed and so located that the front is in the museum and the back in a preparation room. Arranged in this manner it may be used for general refrigeration without interfering with the displays. Its location and arrangement are shown in Figs. 1 and 3; a diagrammatic section, showing construction and insulation, is given in Fig. 5.

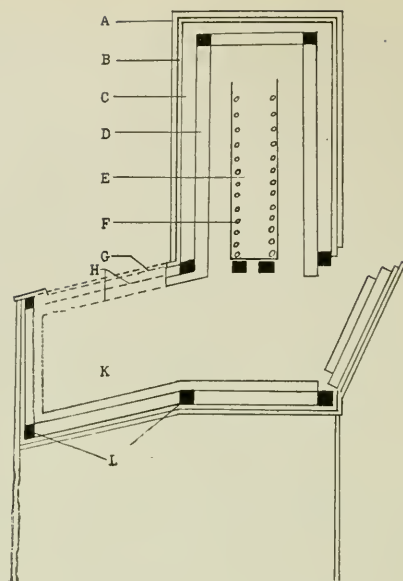


FIG. 5.—MUSEUM DISPLAY REFRIGERATOR.
Section.

The above diagram is not drawn to scale but from the following description and a study of Fig. 3, there should be no difficulty in grasping all essential details.

A, Outer layer of oak $\frac{7}{8}$ in.

B, Yellow pine sheathing $\frac{7}{8}$ in.

C, Outer layer of compressed cork 3 in. in thickness

D, Inner layer of compressed cork 2 in. in thickness.

The yellow pine sheathing and all interior wood is heavily creosoted. Between the oak and pine is a layer of heavy tarred building paper. Between the pine and outer layer of cork and between the two layers of cork is first a layer of asphalt then a layer of tarred paper covered by another layer of asphalt. Where blocks of compressed cork join they are cemented together with asphalt. The asphalt should be liquified by heat and applied very hot. The interior is lined with 16-oz. copper tinned on inner surface, all joints soldered, and drained with trap to sewer from lowest point in chamber marked *K*. The frame of 3 in. by 3 in. yellow pine indicated in section by solid blocks is heavily creosoted, two of the sectioned frame pieces are indicated at *L*.

E, Tank of galvanized iron 7 ft. long, 2 ft. high, 10 in. thick, filled with calcium chlorid brine (sp. gr. 1.104) and containing coils of 1 in. iron pipe *F* in which ammonia expansion occurs.

G, Plate glass $\frac{1}{4}$ in. thick set in felt.

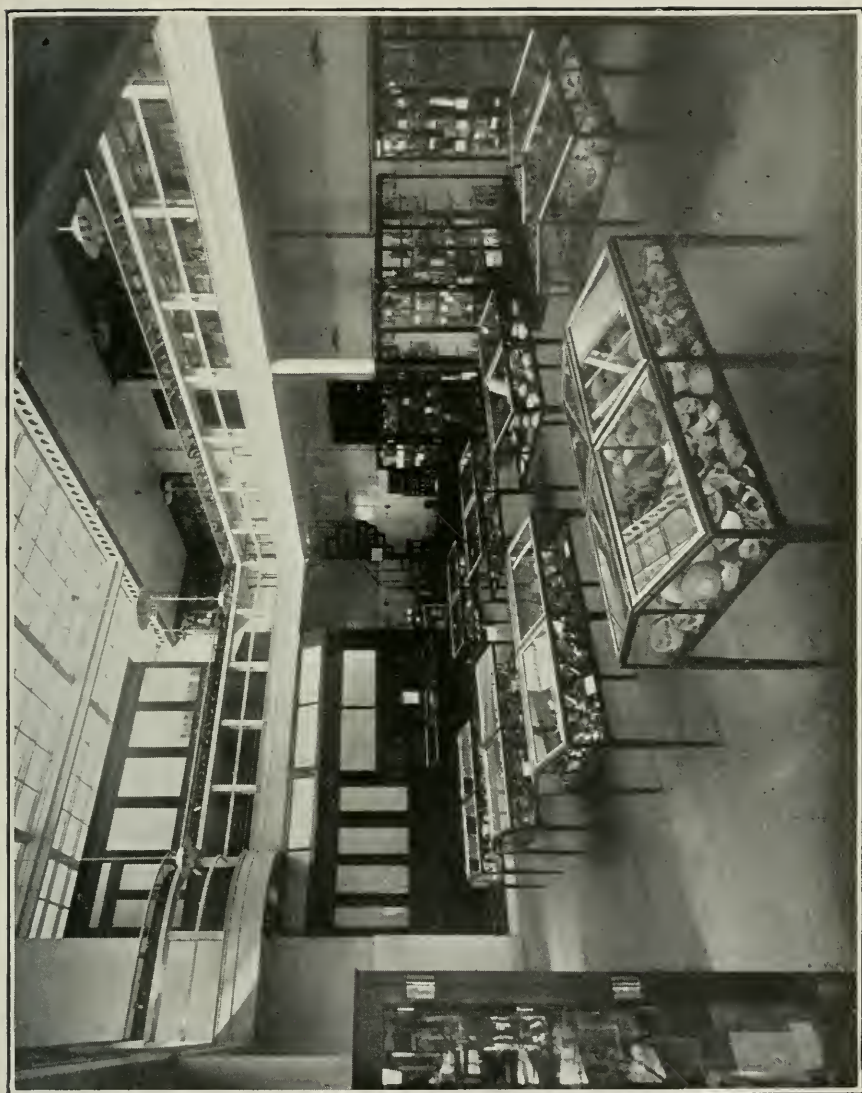


FIG. 1.—MUSEUM, Jefferson Medical College.

Illustration shows main floor and part of balcony. Rail cases around light-well and repair room on balcony. In foreground double flat cases of steel and glass. At back Museum refrigerator.

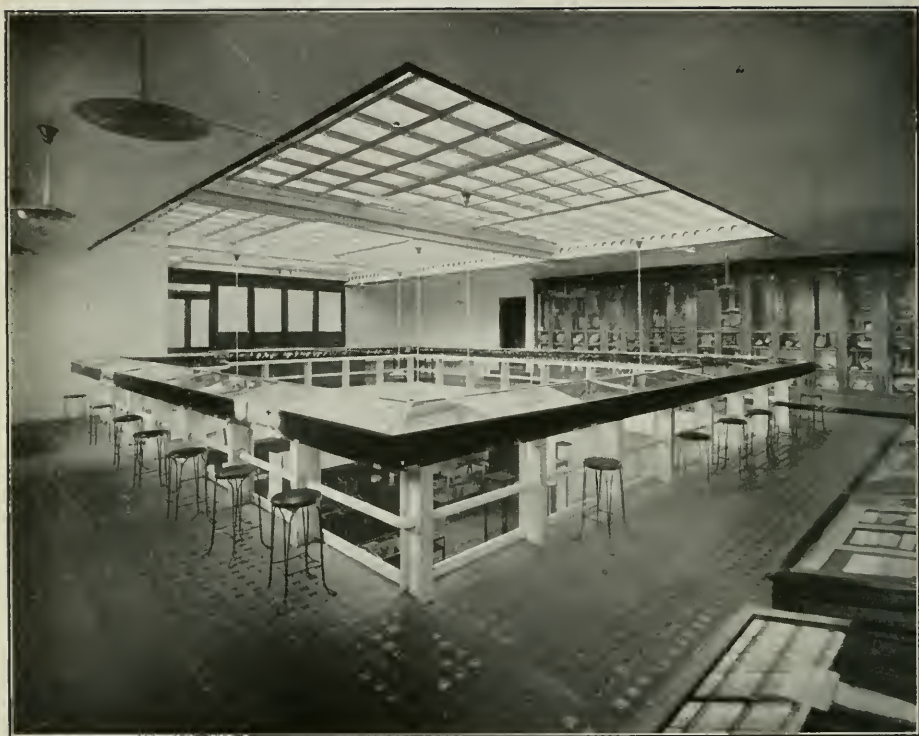


FIG. 2.—MUSEUM BALCONY.
Jefferson Medical College.

Bone cases around light-well. In background room used for repairing models, etc. Diffusing glass of skylight shown above.

This picture was especially taken to show vault light floor construction adapted to museum purposes.

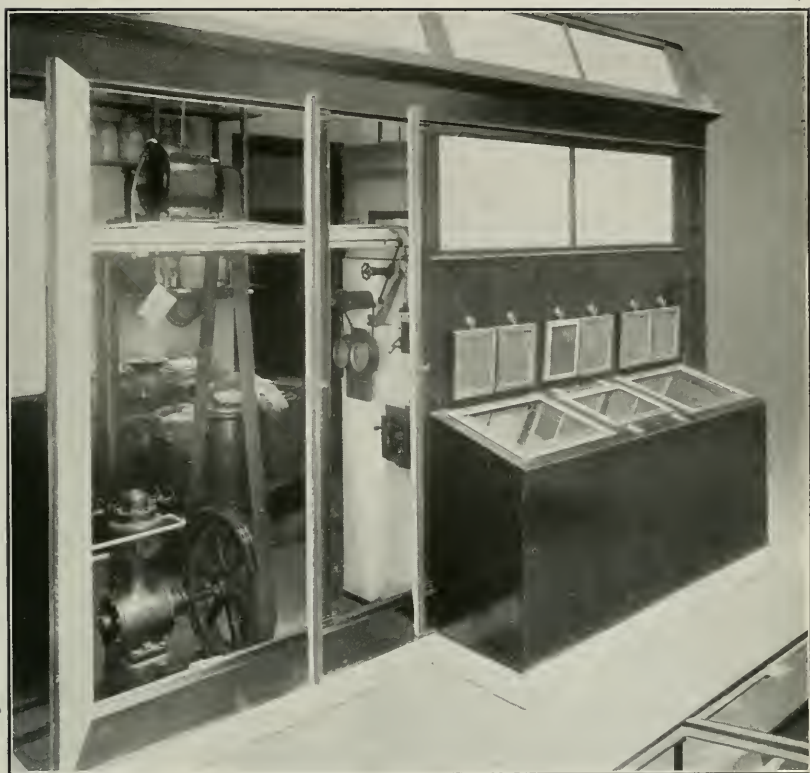


FIG. 3.—EXHIBITION REFRIGERATOR.
Museum of The Jefferson Medical College.

Refrigerator showing three glass-covered rectangular windows through which specimens are viewed; above the windows are photographic printing frames containing clinical histories, postmortem notes, drawings, temperature charts and other data with regard to specimens exposed to view.

Doors of room (12 by 16 ft., housing machinery and back of refrigerator) are open, showing one end of refrigerator starting-box, gauges, expansion valve, etc. In lower left of room is ammonia compressor driven by belt from motor ($1\frac{1}{4}$ horse power) above. This enclosure is also used as "fixing room" and stock room. Stone jars (20 gal. each) contain fixing and preserving solutions. Back doors of refrigerator cannot be seen from this side.

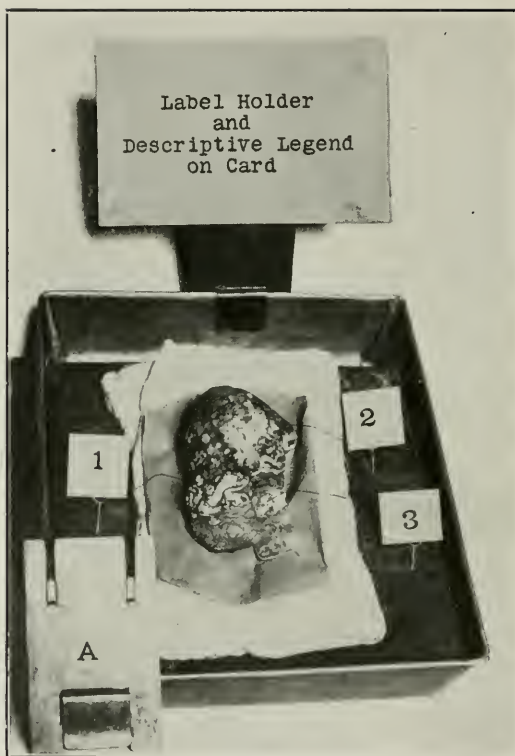


FIG. 4.

Showing method used to display specimens. Cork in bottom of pan. Gauze pad with layer of filter paper under specimen. Leaders 1, 2, 3, consisting of cards held in split-pins stuck in cork. From each split-pin a flexible wire runs to point on specimen. Below to the left at "A" is shown label holder that fits over rim of pan to hold large label as shown at top of pan.



FIG. 6.—MUSEUM CASE; CLOSED TYPE, WITH SHELVES.

The Jefferson Medical College.

Steel and plate glass; part of base next floor is slate; 9 ft. long, 7 ft. high, 2 ft. wide. This case has 24 glass shelves exclusive of bottom. Each shelf is separately or independently adjustable.



FIG. 7.—MUSEUM CASE; SHELFLESS TYPE.
The Jefferson Medical College.

Steel, glass and slate museum case, 9 ft. long, 7 ft. high, 2 ft. wide. Each jar rests upon an independent support. Although case is not as yet filled observe that the introduction of long and short jars results in no striking hiatus such as under ordinary circumstances inevitably appears in shelved cases.



FIG. 9.—MUSEUM CASE; OPEN TYPE FOR DEMONSTRATIONS.

The Jefferson Medical College.

Built of steel, glass and slate. Uprights and frame of steel; glass shelves on adjustable steel brackets; base of steel and slate. Both sides are exactly alike; shelves of each side and of each section are adjustable independently. Each case is 9 ft. long and 6 ft. high (should have been not over 5 ft. 3 in.), each independent adjustable shelf is a piece of $\frac{1}{2}$ in. plate glass 10 in. wide, 27 in. long and resting on T-iron supports. All together there are 24 such shelves; in addition top of framed plate glass and upper surface of base are also used as shelves extending full length of case.

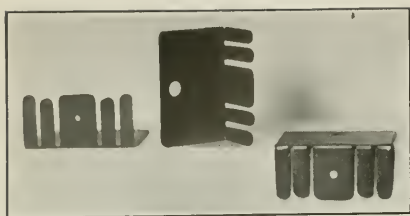


FIG. 10.—THREE VIEWS OF LABEL HOLDER.

Larger opening in solid base shown in center is for applying holder to old-style clamp jars as in fig. 12. Small hole in central holding finger is for pin to retain label in position when holder is used upside-down as on right. Figures are little more than half natural size.

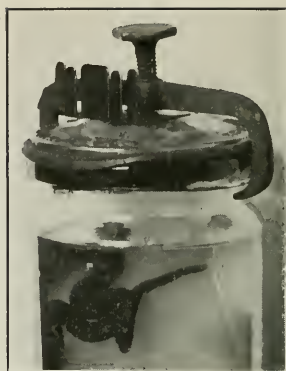


FIG. 12.

Label holder applied to ordinary old-style, round jar with lid clamp.

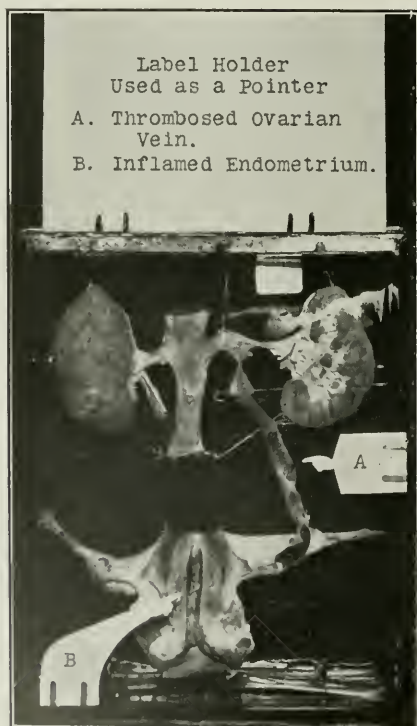


FIG. 13.

Label holder used for holding pointers or leaders, calling attention to special features. Card on top of jar displays descriptive legend.

H, Leaders indicate intermediate and lower glasses of extra heavy clear window glass also set in felt. Felt not shown.

The box *K* used for specimens is 8 ft. long, 1 ft. from lower surface of inner glass to bottom and from front (on left) to door at back 3 ft. 6 in. Specimens are exhibited at point occupied by letter *K*. The tops of thick and thin specimens are brought to the same level by cork blocks beneath the display pans. There are three windows; these at ends (see Fig. 3) are 26 in. by 18 in. each. The center window is hinged, the frame takes up some room, consequently the glass is only 20 in. by 14 in. This door is probably unnecessary; every part of the box can be reached from behind; its one advantage is that when open it loses much less air than through the back doors. As one back door 8 ft. long would be heavy and cumbersome two doors with removable intervening stile are used; necessarily but one of these shows in section.

Heavy pine supports (3 by 3 in.) on which box rests are not shown in section. Space under box is closed by doors behind and is used for storage.

SERVICE AND OTHER ROOMS; SPACE ALLOTMENT; SPECIAL TECHNIC.

As auxiliary rooms every museum should have a space suitable for taking photographs and a properly equipped dark room. In the photographic room must be facilities for storing cameras, lenses, plate holders, printing frames, devices for posing, and different colored cloths, papers or cards for backgrounds. Cabinets for receiving plates and negatives are also necessary.

There should be a room where a specimen may be posed for drawing and when injury would not result, as in the case of drawings made of specimens in jars or of dry specimens such as bones, the position of the posed object should not be disturbed until the drawing has been completed, and if possible, approved. It is so difficult to re-arrange even a bone to get exactly the same lighting and as the artist is usually not a medical person, frequently a woman, there is a disinclination to handle material.

A room suitable for the deposit of specimens for some individual investigation by teacher or research worker, should be supplied. In such quarters may be grouped all specimens illustrative of some point and the investigator may arrange them in any manner suited to his fancy; assembled organs may be from cadavers of the same age, or of different ages; the height, or duration of the affection may be a basis for arrangement, etc. The morbid anatomy of any particular fracture is best appreciated by grouping a number of illustrative specimens. During the courses of such studies quiet and seclusion are necessary; open space in a museum or even an alcove cannot be used for such purposes.

There should also be available a room in which groups of specimens used on successive days may be temporarily placed. Most injury to museum material occurs during removal from or return to its proper place on shelves or in cases and when possible unnecessary handling should be avoided; besides, it is time-consuming and consequently a source of expense.

It is most discouraging to curator and preparator to be obliged to get out apparatus and utensils every time they are needed. Glass-blowing appliances, files and other tools, burner, bellows, etc., should be assembled in suitable locations and not disturbed. The same is true of scales, containers of chemicals, and solutions frequently or almost constantly in use. Space for storing rods used to make supports and for keeping stock sizes of glass frames is desirable.

Every museum should possess a band saw, preferably power-driven, and space for storing a dozen or more saws of different sizes and "set." By no other means can satisfactory sections be made of bones and calculi. Cross-section anatomy has opened up an entirely new teaching method. Relation of tuberculosis and abscess cavities in lungs or other organs to the surface and to other structures, adhesions in pleura, pericardium and peritoneum, abscess of the brain or meningitis due to middle ear or mastoid disease, arthritis resulting from osteomyelitis, and some diseases of the vertebræ can in no other manner be satisfactorily prepared for exhibition. Our methods of sawing by hand even by the most expert are miserably inadequate. Of course where specimens illustrating normal anatomy are prepared the equipment is the more necessary.

Pots, kettles, ovens and like appliances for warming cements and heating lids preparatory to cementing jars, for warming gelatin, agar, wax and other injecting materials, the stands and supports for such utensils, and the gas stoves or burners by which the heat is applied all require space. A carpenter's bench and facilities for storing necessary tools are also required.

It is astonishing how many sizes of jars are needed. Often one feels that no two specimens can be properly displayed in jars of the same size. However, every museum is forced sooner or later to fix upon probably forty to fifty sizes and rarely, if ever, add to the group decided upon. We have in the rectangular shape more than fifty sizes. It is all very well to use large jars and a few sizes; the increased expense, not only of the jar but for preserving fluids as well must be considered. Besides, the smaller the jar the lighter and more convenient. This selection of the smallest jar applicable is what forces upon us so large a list.

In order to facilitate selection and reduce to a minimum waste of time and energy, we keep in one place, immediately accessible to the preparation room, a set of samples of every jar we use. Each jar should be labeled, the label setting forth the size and catalogue number indicating on what shelf and in what place jars of the same dimensions are kept. We gradually are making this sample collection out of cracked, nicked and otherwise defective jars: such accumulate all too rapidly. When the preparator wishes to determine what jar to use he places the specimen in a pan on a table before the sample collection, and by trial decides the size required. The label shows just where the stock is kept. If we had available room all the stock of 500 or 600 jars could be kept in view: as it is we have room for storing, immediately accessible, and ready for use not more than three or four washed jars of the smaller sizes and none of the larger: when one of the latter is needed it must be brought from stock.

Rooms well lighted are needed for making necessary dissections, posing specimens, carrying them through the necessary stages and required solutions and finally for mounting them. We are hopelessly cramped. Frequently a mounted specimen cannot go on the shelf for days or weeks or sometimes months after the mount is completed and ready for sealing. The history must be obtained, the microscopic and often the bacteriologic examination completed; until the morbid histology has been satisfactorily determined and one is sure more tissues will not be needed for sections, the jar should not be sealed. Very often a clinician wishes to show a specimen at some society meeting and desires a drawing made; or other specimens must be rushed through for one or more of the foregoing or for other reasons, and the preparation of a specimen that might be completed is interrupted; it must be stored until time is available for again taking it up. This requires room.

Models are less used than formerly, but for some purposes cannot be surpassed. Models of the ear, eye, larynx, glands, reconstructed enlargements of developing embryos, of the central nervous system and similar preparations of papier maché, and modelling composition or wax, are exceedingly useful. Even models of bacteria, higher fungi, protozoa and insects are of value. If a museum possesses such models a room in which repairs can be made and colors retouched becomes necessary.

Bones must be macerated and degreased, dried, and bleached, fractures assembled, joints articulated and final mounts made. I have said nothing about boiling bones; I doubt if any method in

which boiling forms a part, is acceptable; if alkalis are added the process is still more destructive. The finest bones in our collection were prepared by or under the direction of the elder Gross—some of them more than 50 years ago—and are as good as ever. I have been told that they were macerated and sunned—nothing more. Light and gentle warmth seem to be the only safe bleaching combination. Most of our additions, made during the last twenty years, are keeping badly, the more brittle specimens have become quite useless. The old method is time-consuming and wasteful of space but it is the only trustworthy technic I know and I have personally conducted and seen tried many experiments. Even maceration must be watched. No technic that has stood a test for less than five years, preferably ten or longer, should be adopted. For any process selected an independent well-lighted and properly ventilated room or group of rooms is necessary. In the Washington University Medical School, rooms for this and similar purposes open on the roof and have no internal communication with any other part of the building. The plan is by far the best I have seen; a separate building would be asking too much.

I have said nothing about room for fixation, infiltration, staining, mounting and histologic study of museum material. Our laboratories of morbid histology and bacteriology are very near the museum, and in consideration of our crowded facilities, the workers in those departments are charitable to intrusions from the museum. If, without great inconvenience to others, space for histologic and bacteriologic study can be secured, better satisfied curators, preparators and other assistants can be obtained.

I have gone into this with some detail to indicate how much room is absolutely necessary for economic utilization of employee's time, for after all the real expense of museum organization is in labor. If conditions are created by which time is not wasted, necessarily wasted, much more can be accomplished and conspicuous results attained without great outlay. Doing the best I can the result in growth and up-keep of our collection often appears disappointing. In crowded quarters volunteer assistance cannot be expected and largely from such a source vacancies in the personnel are to be filled.

MUSEUM CASES OF METAL AND GLASS.

All old museums are equipped with wood cases. These do not permit the use of large glass doors, are not dust-proof, and when opened frequently are not durable; changing temperature

and humidity widen cracks and cause warping. In fitting up the old museum we installed several thousand dollars' worth of cases and did not feel inclined to discard them. In the new museum they were used for balcony wall cases, partitions and doors. All new cases are of steel and glass. The large cases are 7 ft. in height—6 ft. inside, 1 ft. base; length 9 ft., width 2 ft.; for most purposes they are needlessly wide. A four-inch slate strip immediately at the floor prevents cleaners from knocking off paint and wetting metal which consequently rusts, becomes unsightly and stains the floor. The slate is cemented to the floor so that dust and water cannot get under the case. Each case has four doors, two on each side; the doors are closed by a three-way locking device throwing bolts at top, bottom and in center. All sides and top of case are $\frac{3}{16}$ in. plate glass; there are no partitions. The glass in each door measures 5 ft. 7 in. high and 4 ft. in width. Some of the cases are fitted with shelves (four to the case and every shelf adjustable in two or three sections) others are equipped with an adjustable device by which every jar except the smallest has its own support. (See Fig. 7.) A few of the cases are shelved through the center and with adjustable individual jar supports at the ends. The advantage of an adjustable mechanism by which each jar is supported independently of all others lies in the fact that a very tall jar does not require an entire length of shelf space of its height. The next jars on either side may be so placed as to permit two or even three heights of bases and consequently of jars; the arrangement is most economical.

The steel flat cases are conventional in size and design; each case is 6 ft. in length; around the balcony rail the sections are bolted together without ends, making one continuous case. These are shown around balcony rail in Fig. 2. A 6-ft. section is supplied with two doors. The sizes so far installed are (A) 5 in. high in front and 7 in. at back, width 16 in.; these are adapted to small specimens such as eyes and to flat Petri dish and clock-glass mounts. (B) Six inches high in front, 9 in. at back and 21 in. wide; in cases of this size all our fractures and diseased bones are placed. (C) Flat double cases (two fronts) each front is 10 in. high, the center 12 in. high and the total width 44 in. These occupy center of museum and are shown in Fig. 1. They contain skulls, pelvises, and articulated trunks showing tuberculosis of vertebræ, crushes of ribs, etc. It is probable that other depths will be found desirable.

Because they were not dust-proof our old wood cases were sources of endless cleaning; neither case nor contents ever looked

clean. Dr. Greenman¹⁰ of the Wistar Institute has designed and constructed large cases dust-proofed by the use of cotton set in a groove into which a tongue of metal enters; they are admirable in every respect. The joint is very satisfactory provided the cotton is properly distributed and stays in place. It seemed to me that a strip of cotton felt might be better; now that we have tried it I am not so confident; it is more easily placed and kept in position. The accompanying drawing (Fig. 8) shows the arrangement. Our locking device is rather crude but seems to accomplish the purpose for which it was designed. All cases are dust-proofed and locked alike; one key opens all.

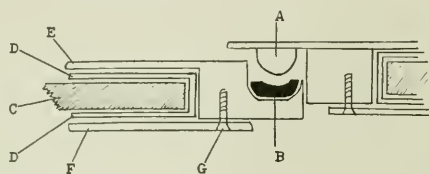


FIG. 8.—DUST-PROOFING OF MUSEUM CASES.

Horizontal section of doors at point where they overlap. Drawing is not to scale but diagrammatically shows how felt is used for dust-proofing. *A*, Half-round molding, bead or tongue, welded to overlapping steel of door frame and when closed pressing upon felt, *B*, cemented in groove in other door or in frame of case. This felt-lined groove entirely surrounds frame and at every point receives, when door is shut, the metal tongue *A*.

E, External steel of door. *D*, *D*, Felt entirely surrounding plate glass *C*, and held in position by inside molding, *F*, secured by screw *G*. All glass is set in felt. Locking device is not shown.

DEMONSTRATION CASES.—In addition to the closed cases we have installed two open cases (Fig. 9) upon which are placed groups of specimens illustrating subjects upon which lectures are being given. For example, when the professor of practice or of pathology is presenting endocarditis a group of hearts and of separate valves is placed on one of the open cases. Each specimen is supplied with a descriptive label on which, when known, an epitome of the clinical history and postmortem findings is also given. In a group we attempt orderly presentation by arrangement of acute and chronic, active and quiescent, and other types, if possible showing stages by juxtaposed specimens. When cancer of the mamma is shown, anterior and posterior views, section through the nipple and sections to and through involved muscle, fat and

¹⁰ Wistar Institute of Anatomy and Biology, Phila., Bull. 3, 1910.

lymph-nodes, are placed on exhibition. The student may turn the jars or from the two sides of the doorless case see both aspects. Models and drawings may also be assembled with the specimens. Specimens illustrating complications, or groups from an interesting and instructive case, may be assembled; for example in pneumonia, the lung, heart, spleen, kidney and any other organ involved are exhibited side by side. For typhoid the exhibit includes intestines, mesenteric lymph-nodes, spleen, gall-bladder, peritoneum showing result of perforation, pyelitis, nephritis, etc., and colored drawings or plates showing eruption, tongue, etc. Groups of students may be brought before the exposed collection for brief demonstrations. The plan is most acceptable and useful.

PREPARATION OF MATERIAL¹¹

For routine preparation the Kaiserling method is used. Although not unfamiliar with most technic from time to time advised, I have found nothing better than this well-known method. All important details have been repeatedly published. Filtration of the final preservative through animal charcoal gives a limpidity not otherwise obtainable. Many specimens can be mounted and sealed in jars without submersion in fluid. Some thymol and enough fluid to maintain humidity is all that is necessary provided the specimen is not permitted to touch the sides of the jar. Whether in air or fluid, a glass frame is necessary, and this may readily be so constructed as to hold tissues away from the jar. Much as the gelatin method has been criticized it has its uses; I have mounts now more than ten years old that are as perfect as when prepared, every color detail is excellent. Loss of color in fluid mounts is due to the macerating influence of water and glycerin; such action is reduced to a minimum by the use of a medium that does not permit the fluid in contact with a cell to change its position, each new contact causing some extraction until a homogeneous levelling has ruined the specimen. Gelatin prevents such action. I have tried oil but have found no way to secure a satisfactory seal, without which material is useless for teaching purposes. I am satisfied that the gelatin method recently published by Delépine¹² will be found acceptable, possibly better than any previously published, but I have not experimented

¹¹ See Robertson and others, *Internat. Assoc. Med. Museums*, Bull. IV. Coplin, *Jour. Amer. Med. Assoc.*, Aug. 13, 1904, also *Manual of Pathology*, 5th ed., p. 1037.

¹² *Jour. Path. and Bact.*, Vol. XVIII, p. 345, Jan., 1914.

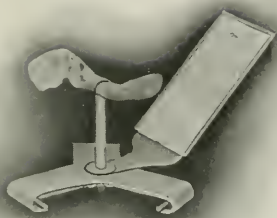
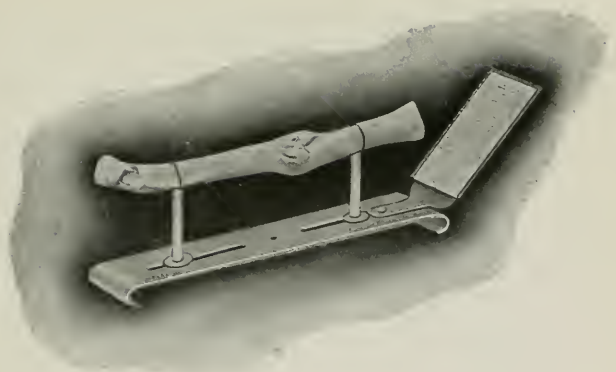
with it sufficiently long to speak with confidence. Mounting in air seems to merit further trial; before closing air-tight by finally sealing small hole in lid the container should be thoroughly warmed in order to rarify the air and prevent expansion from raising the lid during warm summer days, when the room is otherwise warmed or the jar long handled as during demonstrations. Dried emphysematous lungs are beautifully preserved in this manner. To prevent growth of fungi I have secured to the glass frame a test-tube filled with cotton the deeper layers of which are saturated with phenol; carbolic vapor is better than thymol or camphor, does not condense on sides of jar and so far as I can see has not bleached colors. Most of our material is in final Kaiserling, some in gelatin and air mounting is on trial.

An exceptionally beautiful result is obtained by placing a blue glass back of specimens only one side of which it is desired to display; other colors may also be used. I first saw the method applied by Mr. Silvester of Princeton. The backs of jars may be painted black. White (not clear) celluloid may be used either within or on the outside of jars. Prof. Stiles uses plaster of Paris to which he also fixes his exquisite dissections before placing them in jars; the plaster may be colored with insoluble marine blue or rendered gray by the addition of charcoal.

SEALING JARS.

In the last fifteen years, during which time we have been experimenting with sealable jars, a vast host of confident representatives has visited us. If their products had been purchased few came twice. A perfectly satisfactory sealing agent is to me quite unknown. That prepared by Mr. E. L. Judah has given us the best results; his directions¹³ are followed exactly, except that we use an oven of the ordinary water-bath drying-oven type in which the carefully cleaned lids are placed and heated to 100°C. When the jar, prepared as directed, is ready the door of the oven is quickly opened, the hot lid removed and placed in position at once; the door of the oven must be opened as infrequently and for as brief periods as possible. I have intended to raise the boiling point of the contained water, and consequently the temperature of oven and lids, by the addition of salt but so far have not experimented. The little addition to technic is helpful; lids are not so readily broken by additional flaming when necessary and, of course, if placed in the cold oven, when about to begin sealing

¹³ Internat. Assoc. Med. Museums, Bull. V.



FIGS. 14 AND 15.

BONE MOUNTS AND LABEL
HOLDERS.

Museum of Jefferson Medical
College.

Mount proper is all steel, gun-metal finish, lacquered; wire passing around bone is soft untempered brass.

Each mount comes unassembled ("knocked down") and comprises 3 or more

parts: the base, is 1 piece of sheet steel 16 to 25 gauge depending on length of holder. In long mounts (on left) 2 slots each 4 in. to 6 in. long and $\frac{1}{4}$ in. wide, permit adjustment of uprights to acceptable points on bone. Each upright consists of an outer tubular support on the lower end of which is brazed a disc giving broader and more secure bearing on base. Running through the tubular support is a threaded eye-bolt upon which, below base, a winged nut screws on. The wire is passed around bone; each end is passed through eye of eye-bolt and turned back; eye-bolt is then passed through tubular support, a lower washer applied below base and winged nut, screwed sufficiently tight to hold bone securely. Very soft or fragile bones may be surrounded by a ring of felt beneath wire and a felt washer over vertical support. Instead of wire catgut, linen cord or other substance more pliable than wire may be used. When bone is too soft to stand pressure it (bone) is waxed to a wood plug which is wired to vertical support. Label holder may be attached to either end, or through hole in center or at any point along either slot. In triangular or tripod mounts (on right) it is caught by eyebolt passing through hole in label holder. Label holder like other parts of mount should be steel, gun-metal finish, and lacquered. Card contained in holder may be covered by celluloid.

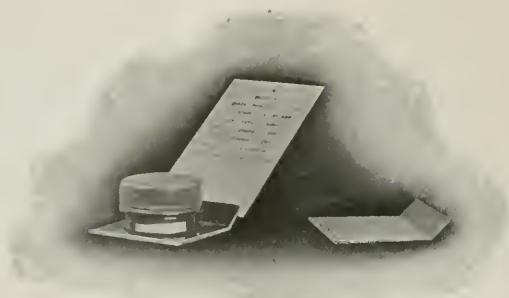


FIG. 16.—LABEL HOLDER FOR EYE-MOUNTS.
May be used for any small mount readily cemented to holder.

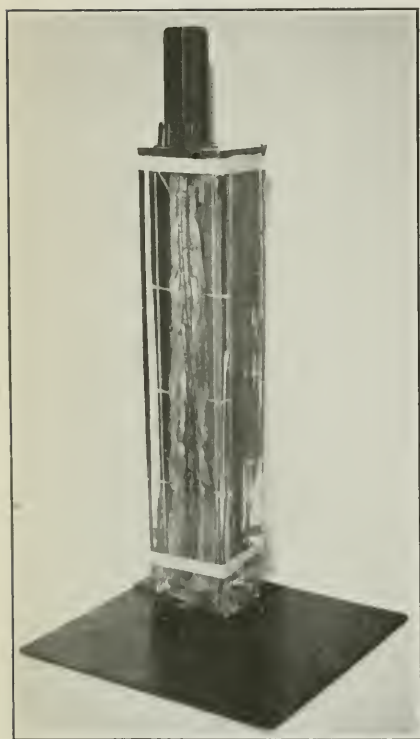


FIG. 17.—SUPPORT FOR TALL JAR.
Upright is electric-welded to base. Jar held to upright by rubber band at top and another at bottom.

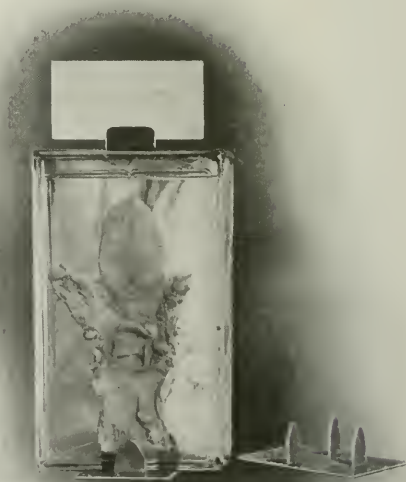


FIG. 18.—SUPPORT FOR TALL THIN JARS.
Description in Text.

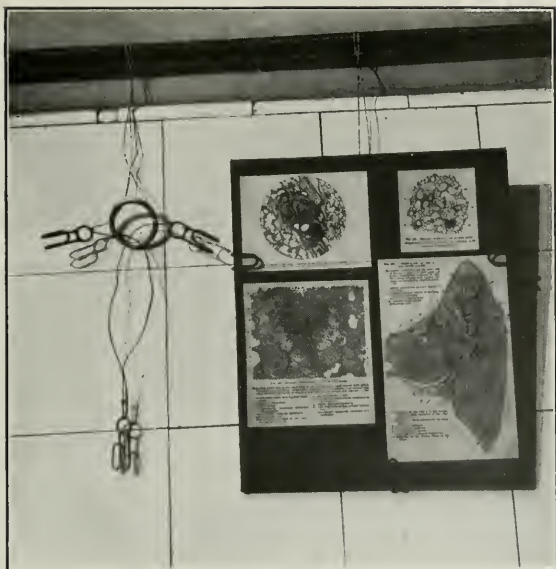


FIG. 19.

Method of hanging pictures (plates, photographs, etc.) mounted behind glass passe par tout. On right, plate in position; on left, empty holder showing wire, ring and hooks. The wire above is looped over a tubular rail just above tile.

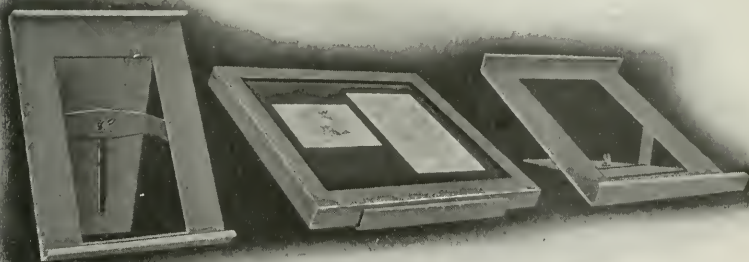


FIG. 20.—EASEL FOR HOLDING MOUNTED PLATES, GELATIN AND SIMILAR MOUNTS.

The easel may stand erect as on left, or lie down as on right. In center is shown mounted plate in plate holder resting on easel in flat position.



FIG. 21.—MUSEUM TRUCK.

Museum of Jefferson Medical College.

Length 42 in. Height (from floor) 48 in. Width 30 in. (Should be smaller, about 30 x 20; height 36 in.)

All steel. Shelves covered with corrugated red rubber $\frac{1}{8}$ -in. thick, cemented on. A 1-in. cushion, one-piece bicycle tire runs completely around middle shelf and projects sufficiently to cushion all contacts; to prevent scarring cases, walls, doorways, etc.; to lessen likelihood of breaking glass in doors, cases, etc. All wheels are pivoted and rubber-tired.

a number of jars, and all heated from room temperature with oven doors closed no breakage results. The plain asphaltum as recommended by Day¹⁴ may work as well; I do not know. No cement can be commended until time has established its value; by time I means years. We have had to repair several mounts made in Germany by the parties referred to by Day. Any good asphaltum varnish, preferably of the quick-drying type may be used to preserve asphaltum mounts. I fancy that when the cement is in prolonged contact with a fluid containing glycerin or alcohol, we shall find that a fresh surface dressing is necessary to indefinite preservation. We have some jars covered with pig's bladder drawn over a thin sheet of lead and coated on the outside with varnish; the mounts are very old; one in excellent condition was prepared by Prof. John K. Mitchell, certainly 55 years ago. The preserving fluid is evidently alcohol. The original varnish was not asphaltum, probably shellac; in the re-varnishings of 1899 and 1910 asphaltum was used; they are now in good condition. Some jars sealed with hot 2 per cent. agar in 1903 had to be broken to get open in 1912. Others did not hold. Nothing seals mounts in oil; agar comes near but is not sure; several proprietary glues and cements used in the cold are nothing but agar or cheaper glue with the addition of acetic acid or coloring matter, or both. I do not know what good the acid accomplishes. Gelatin, chromicized or plain, may be used, but is not as good as agar or high-grade glue. I have seen the regulation glycerin and litharge mixture used by plumbers tried, but cannot commend it even for Kaiserling mounts. The one advantage of asphaltum is that even when applied to edge of clock-glass, Petri dish or other container, and immersed it will afford a temporary seal which may be set and reinforced after removal from the fluid. But asphaltum will be found fickle. The chemist in a large plant where asphaltum varnishes are made advises me that samples from two ends of the same barrel may vary physically.

For closing the small opening in lids we use a bit of wood (cork will answer) dipped in sealing wax and thrust into position hot; a drop of wax is put over it. It is easy to get out; asphaltum is not. Label holders are fastened on jars with letter wax.

LABELING.

Probably in no important detail or routine museum technic is there so much diversity of opinion and practice. I shall state our methods. Immediately upon receipt of a specimen and while it

¹⁴Trans. Chicago Path. Soc., March 1, 1913, Vol. IX, p. 106.

is in course of preparation we affix to it with a linen thread an aluminum tag $1\frac{1}{4}$ by 1 in. on which is stamped the accession number. If no salts of mercury, copper, iron or allied metals enter the fluid or have access to the tag it tarnishes but little. Recently, after the number is stamped in by the use of steel dies, the tags are heated over a Bunsen flame, dropped into bee's wax, removed and drained while hot. So prepared they corrode less or not at all. When ready to seal the tag is permanently attached to the specimen or to the glass frame. Because some of our tags corroded, particularly those on old specimens and probably as a result of the presence of mercury, chromium or other corrosive salt, we are now cementing all tags to the glass lids. In this position they are easy to find, more legible and do not corrode. If a number of jars were simultaneously smashed into a single jumble confusion might result; the likelihood of such an accident is rather remote. To loose specimens in the morbid anatomy collection repeatedly examined by students, aluminum wire is used to attach tags of the same material.

Harlan J. Smith properly expresses the value of labeling, "A museum may better do without many specimens than to be lacking in the most essential labels."¹⁵ The ideal would be a photograph of the specimen mounted by side of, or on top of jar. The photograph should be of the specimen exactly as mounted and on the former should be placed leaders with full legends, preferably typed. We have a few such labels; their preparation is time-consuming and they are expensive. Book illustrations or drawings may serve the same purpose.

We have tried labels gummed or otherwise directly placed on jars. As all jars must be cleaned, especially when they are handled, attached labels become soiled and illegible. Again we use our specimens in practical examinations and consequently must be able readily to remove and to replace labels. In our morbid anatomy demonstrations we use many jars with card holders of a special type. I have described them elsewhere.¹⁶ Of this we have but one size, the expense of a group of assorted sizes with clamp would be prohibitive.

For general use we have had made a special label holder (Fig. 10) that may be attached to any rectangular jar in eight positions, two to each margin (see Fig. 11) and may also be used on the old style cylindric clamp jar of the Whitall Tatum type (see Fig. 12).

¹⁵ Scientific American Supplement, No. 2056, May 29, 1915, p. 348. A good description of an inexpensive museum case is also given.

¹⁶ Jour. Amer. Med. Assoc., Aug. 13, 1904.

For large labels, six to eight inches in length two holders are needed. Depending upon the quantity ordered such special metal holders, gun-metal finish, lacquered, cost from two and a half to five cents each.

When for any purpose a jar is removed from a case the position it occupied is indicated by label holder containing the jar number so that when the janitor returns the jar he may know exactly where it belongs; if on the label used to mark the place the name or initials of the party who removed the jar be placed an absent specimen may be more readily traced. As shown in Fig. 13, these holders may also be used to support leaders and pointers attracting attention to special features.

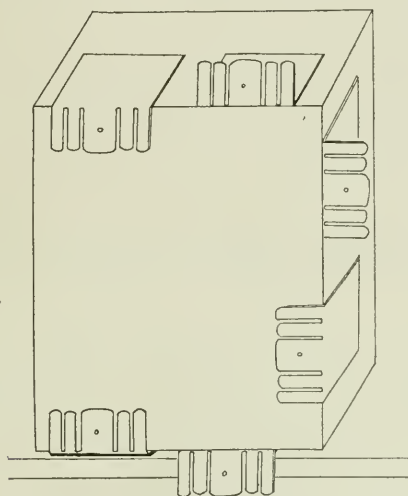


FIG. 11.

Showing positions in which label holder may be applied. The holders are fastened to the jars by wax used for sealing letters. The jar surface must be thoroughly cleaned, the wax placed upon the holder which is held in pliers and fully liquefied by heating under side of holder; apply quickly and press into position.

BONE MOUNTS.

Many bones in our collection were mounted; all sorts of devices had been employed, resulting in a heterogeneous assemblage that could not be displayed to advantage. Most of the specimens were unmounted. After numerous experiments the mounts shown in Figs. 14 and 15 were evolved; with the label holders attached the mounts are attractive and durable. The mounting devices con-

sist of bases and supports. The bases of those for bones requiring at least two points of support are made of sheet steel (gauge 20), curved down at the ends and supplied with a longitudinal central slot at each end and a hole in the middle. Three lengths are necessary, 12 in., 15 in., and 20 in.; we also had these in three widths, but this was unnecessary; they should all be the same width, $3\frac{1}{2}$ in. The vertical supports consist of an outer sheath of $\frac{3}{8}$ -in. tubing at the bottom welded to a washer $\frac{5}{8}$ in. in diam. Through tube and washer passes an eyebolt with winged nut. In order to mount a bone an unannealed brass wire of appropriate size is passed around the bone, the two ends passed through the eye of the eyebolt and bent back; the eyebolt is then passed through the tube and slot in base, the winged nut applied and screwed up until the support becomes rigid. If the bolt projects too far it is cut off. The slot in the base permits such adjustment of supports as may be necessary to secure the bone at points selected. A card label holder is then applied at end or center, or indeed anywhere along either slot, and the mount is ready for labeling.

For bones requiring but a single support, such as clavicles, scapulas, sequestra, parts of skull, and patellas, a sheet metal base shaped to give a tripod effect—three points resting on table—is used (see Fig. 15). The base is supplied with a single hole in the center and the three arms project—equally separated—to a distance of $3\frac{1}{4}$ in. and are turned down in the same manner as the ends of long bases. The mount is made exactly as for the long mounts except that a single support is used and that this support also secures the label holder.

The label holders are of thin sheet metal bent over on both sides and on one end so that they hold a card of the usual catalogue size, 3 by 4 in. Those used on the mounts for long bones are supplied with a short stud-bolt and winged-nut to secure them in place; on the triangular mounts they are placed at the bottom of the single vertical support so that the eyebolt secures the mount and label holder. The label holders for bone mounts are interchangeable. Labels may also be supported by the holder used on jars.

We use the ordinary form of inverted mount for sectioned eye-balls. If these mounts are on shelves the label holder shown in Fig. 10 is adequate. In our Museum the collection is in a flat case consequently a label holder of wider angle (Fig. 16) was devised. The scaled mount is waxed to the holder in position shown in the illustration.

JAR SUPPORTS.

For very tall or very narrow jars Dr. Albert¹⁷ secures stability by cementing a sheet-iron base on each jar. Containers so treated occupy too much shelf room and personally I dislike cement on the bottom of jars. I have had made temporary supports to which top-heavy jars may be attached during demonstrations or while on exhibition in lectures or elsewhere. The jar is secured in place by two rubber bands one at the top the other near the bottom (see Fig. 17).

For very thin jars, top-heavy front and back, but wide enough to be steady laterally, we use a special base made by punching upward three tongue-like projections that rise above the bottom plate about 2 cm.; the thin jar rests on the base grasped between two projections behind and one in front; rectangular jars of the same size as ordered, vary greatly; no holder without expensive provision for adjustment will fit every jar; slight differences, up to 1 or 2 cm., may be compensated for by pieces of cardboard or a wedge of wood inserted between the jar and the two posterior fangs of the holder (see Fig. 18). Even in cases tall jars having one base measurement of 2.5 cm. or less require special supports; otherwise they topple easily.

PLATES AND CHARTS.

The interchangeable charts for museum and demonstration purposes described by Prof. McFarland¹⁸ possess all the advantages he enumerates; my thought was that these were available but once for each student, or at least that the student had an opportunity to see the plate during class-room hours only. It occurred to me to mount the cards as had Prof. McFarland, cover each card with glass, bind with passe partout, and hang them in the museum. They are readily removed from temporary adjustable hanger placed in photographic printing frames as advised by Dr. McFarland, and used in laboratory, lecture room or projectoscope; after use each plate returns to its proper hanger (plates and hangers should be numbered) and may be consulted by the student during spare moments when he visits the museum. Like specimens they are constantly on exhibition. Within reasonable limits hangers receive plates of any size thereby permitting them to be placed always in the proper position.

¹⁷ Henry Albert, M. D. Internat. Assoc. Med. Museums, Bull. IV, Aug. 1, 1913, p. 47.

¹⁸ Joseph McFarland, M.D., Internat. Assoc. Med. Museums, Bull. IV, Aug. 1, 1913, p. 21.

In the two years since we began this plan not a single plate has been broken. The hangers are made by a janitor using special hooks manufactured by a local dealer, rings purchasable in any hardware store, and ordinary picture frame wire. Fig. 19 shows a finished picture hanging and beside the suspended plate an empty hanger. Glass used for covering the mounted pictures is obtained by cleaning discarded plates coming from the hospital X-ray laboratory.

Plates, gelatin mounts, mounted Petri dish cultures and similar flat objects cannot be exhibited to advantage on horizontal shelves. For such objects the all metal easel shown in Fig. 20 was designed. It may be used in two positions, one almost flat, the other supporting the object in a nearly vertical position.

MUSEUM TRUCK.

Specimens are sent to lecture and demonstration rooms on a truck shown in Fig. 21. We use it without trays. The older types of library truck do not carry smoothly enough for museum uses; those of more recent design are useful but rather light. If the same specimens are wanted on successive days the truck may remain loaded. In most instances it is not unloaded in the lecture room, thereby lessening the chances of breakage.

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SOME SUGGESTIONS FOR EQUIPPING A POST-MORTEM ROOM.*

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Following the recent installation of a small postmortem room at the University Hospital, opportunity was afforded for carrying out several ideas which occurred to various members of the staff. Some of these resulted from the necessity for economy but it is believed that the principles involved are sound and will find application in most hospitals where autopsies are performed. The facilities at hand did not permit ideal arrangements in every respect and the following suggestions by no means represent a completed scheme. They are presented with the hope of helping

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8th, 1916.

someone else in solving these particular problems. We are deeply indebted to Dr. L. B. Baldwin, superintendent of the University Hospital, as well as to other members of the staff, for constructive criticism and helpful suggestions in the work of installation. Many of the ideas described below are due to Dr. W. C. Johnson, pathologist to the University Hospital, under whose direction the room is equipped.

1. *Postmortem table.* The frame is made of galvanized pipe as shown in Fig. 1. Its length is 6 ft. 8 in., width 2 ft. 7 in., and height 30 in. Hanging from the lateral and end pipes is a galvanized iron pan which slopes from all sides toward a central drain pipe which leads to a sewer outlet. The slope is quite gradual, the depth at the drainage opening being only about six inches below the surface. On top of this pan and resting on the end pipes is a galvanized wire grating made of No. 8 wire with $\frac{1}{2}$ inch square mesh, bound at the margins by a channel iron frame with a plate covering the outside of the channel. Its width is 2 ft. 4 in., the lateral edges falling just inside the outer margins of the pan (Fig. 2). Underneath the table, resting on cross bars, is a large pan at one end and flat plates at the other. These serve to hold extra hose, head blocks, etc.

The advantages are as follows:

(a) Its comparative cheapness and ease of manufacture. The cost is estimated at about \$50.00.

(b) Its adaptability in height, width, etc., to suit varying conditions.

(c) Constant cleanliness of surface of body and table surface. Blood and other body fluids pass at once into pan. Water can be freely used during and after postmortem without collecting under or around body.

One of the disadvantages of this form of top is the lodging of fibrin shreds and pieces of tissue at the intersection of the wires. It is hoped that this may be obviated by adopting a somewhat different form of top, such as, e. g., a series of cross rods about one inch apart.

2. *Washing pan.* (Fig. 3). Constructed of galvanized iron and oval in shape, measuring 15 in. long, 8 in. wide, and 8 in. high. Bail is of heavy wire and accurately meets the upper margin, which is reinforced. Overflow perforations $\frac{5}{8}$ in. in diameter and located 2 in. below rim extend one-fourth the distance around the pail. A rubber hose reaching to the bottom of the pail conducts water into it.

Advantages:

(a) The oval shape allows it to rest easily on table beside the lower extremities.

(b) The bail fitted to rim permits cleansing intestines by stripping them between bail and rim.

(c) The perforations below rim enable one to immerse an organ in water without causing an overflow from the upper margin. The location of the perforations confines the overflow to one part of the table.

(d) The position of pail and rate of flow are freely adjustable.

(e) The hose can be readily used to flush surface of body, underlying pan, etc., while the pail itself may be easily cleaned and placed out of the way under the table.

3. *Aspiration bottle for fluids.* (Fig. 4.) Located over the sink at a convenient height for reading is a graduated four liter bottle to which is attached a glass douche point on the end of a rubber tube long enough to reach any part of the body. A Chapman filter pump attached to the sink faucet provides sufficient vacuum.

Advantages:

(a) Rapid and complete removal of blood, exudates, and transudates from the body cavities, keeping operation fields clear, and obviating the necessity for excessive sponging.

(b) Ease of measuring amounts of any particular collection of fluid.

(c) Readiness with which any particular fluid may be preserved for subsequent examinations.

(d) Possibility of safely removing dangerously infective fluids, which may later also be thoroughly sterilized, if desirable.

4. *Trays for organs.* Ordinary porcelain enameled serving trays, measuring 16 x 22 in., are used. A sheet of white cardboard is laid on each tray at the beginning of the postmortem. The organs are placed on the cardboard in the trays and these are carried to the examining table located on a drain board at one end of the sink (Fig. 5).

Advantages:

(a) Organs do not slip on the dry cardboard surface and are readily sectioned.

(b) Organs may be separated in such number and grouping as desirable, for both passing around and subsequent examinations.

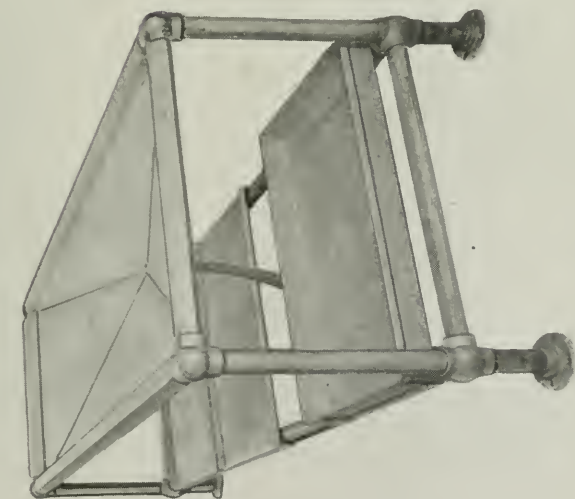


FIG. 1.—AUTOPSY TABLE FRAME WITH PAN.

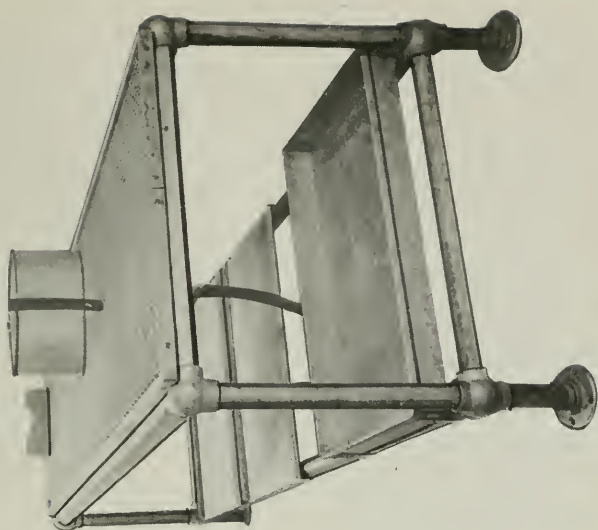


FIG. 2—AUTOPSY TABLE WITH WIRE GRATING TOP.



FIG. 3—OVAL WASHING PAN. BAIL OF HEAVY WIRE. PERFORATIONS BELOW RIM. STRUCTURE OF WIRE GRATING ALSO SHOWN.



FIG. 4—ASPIRATION BOTTLE WITH GRADUATED SCALE, WATER SUCTION PUMP, AND GLASS NOZZLE.



FIG. 5—GENERAL ARRANGEMENT OF AUTOPSY ROOM. TRAYS FOR ORGANS ON DRAIN BOARD. SCALES NOT YET INSTALLED.

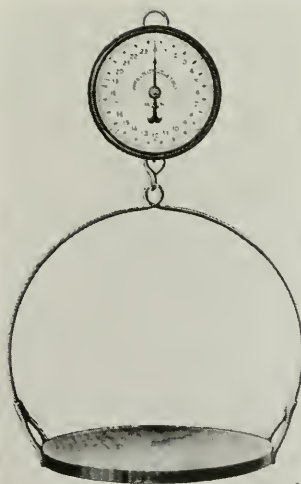


FIG. 6—SCALES FOR LARGE ORGANS.

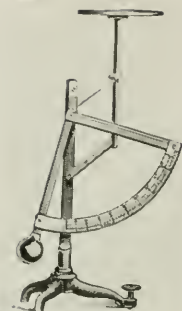


FIG. 7—SCALES FOR SMALL ORGANS.



FIG. 8—SEARING IRON FOR MAKING CULTURES.



FIG. 9—OUTFIT FOR COLLECTING BLOOD FOR CULTURE PURPOSES.

- (c) Trays can be easily cleaned and the cardboard burned.
- (d) Prevention of dripping of blood or exudates on floor or tables.

5. *Scales.* A large spring balance scale, weighing up to 4 kilos and graduated to 5 grams, suspended above the examination table. This balance possesses a clock dial and detachable pan (Fig. 6).

A smaller gravity balance weighing up to 50 grams and graduated in one gram units may be used for weighing smaller objects (Fig. 7).

This type of scale obviates using weights, is handy to read, and can be easily kept clean.

6. *Outfit for making cultures from heart's blood or other cavity fluids.* Consists of a searing iron made of a metal spatula about $1 \times 1\frac{1}{2}$ in. riveted to the end of an ordinary wire handled stove-lid-lifter (Fig. 8). At the mid point of the under surface is set the base of a pyramidal piece of metal about one-quarter inch in height. This is heated over a gas or alcohol lamp flame and laid on the heart or other organ surface, thus furnishing a sterilized area with a central punctured opening.

For withdrawing blood or fluid there is used a previously sterilized 10 c.c. pipette, which is kept protected by inserting lower end into ordinary test tube through a cotton plug and plugging upper end with small bit of cotton. This whole outfit is carried in a long brass tube covered with a cap (Fig. 9).

By this means blood or other fluids may be obtained under conditions which prevent contamination, even when the post-mortem is performed in a private home. It is customary either to pour agar plates directly at the postmortem or else to place the blood in a test tube containing 10 c.c. of a 1% sodium citrate plus $\frac{1}{2}$ % sodium chloride solution, which prevents clotting and allows bacteriological and other examinations to be conducted at a later time.

Museum Technique

A NEW MUSEUM JAR FOR THE PRESERVATION OF EYE SPECIMENS.*

HENRY ALBERT AND VERPLANCK BENNETT, IOWA CITY, IOWA.

The small size of eye specimens and the care that needs to be exercised in mounting such with the idea of properly exposing to view the lesions which are usually of small size and of delicate nature, has made it quite necessary that special jars be used for the mounting of eye specimens.

Several types of such special jars have been placed on the market. The one most commonly used consists of a shallow cylindrical shaped jar, against the flat bottom of which the cut surface of an eye cut in two is supposed to be placed. The cover of the jar is supposed to be sealed on with glue or cement. Of several hundred specimens mounted in this manner, I have seen but few which did not in the course of a few months or years permit evaporation to take place, with consequent shrinkage and cracking of the mounting medium, and in the course of time, deterioration of the specimen.

There is another jar, the sealing of which is accomplished by means of a perforated rubber stopper—the perforated opening of which is sealed with some substance like sealing wax. The results with these jars are even less satisfactory than with the one just described.

In both of these types of jars the label is placed on the outside. The frequent handling of such jars tends not only to cause such labels to be soiled, but in many instances, to come off.

With the idea of so sealing jars that they will remain sealed indefinitely and at the same time of making it impossible to soil or lose the labels, we have designed a new jar or rather modified the jar commonly used.¹

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

¹ Albert, Henry, A New Museum Jar for the Preservation of Eye Specimens. Jour. Amer. Med. Assoc., Oct., 1915. Vol. LXV, pp. 1278 and 1279.

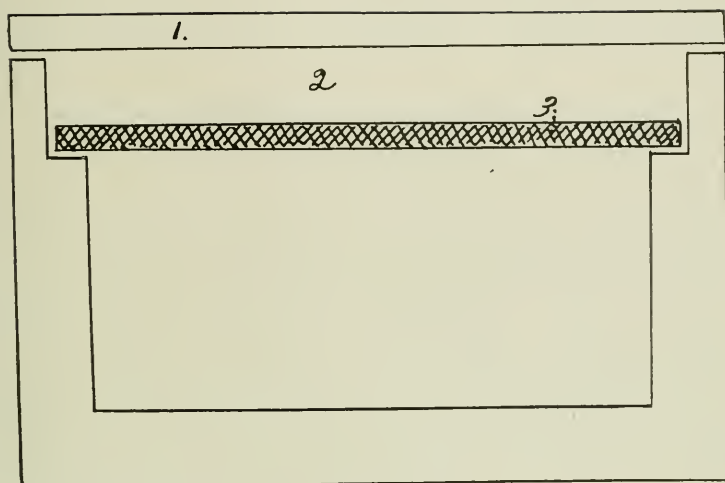


FIG. 1.

1. Outer cover of transparent glass beneath which label is attached.
2. Space between two covers to be filled with marine glue. 3. Inner cover of white opal glass.

Description of New Jar.

The jar, as will be noted from the accompanying illustration, has two covers,—an inner one which rests on a shelf in the jar and an outer one which is for the purpose of sealing the jar. The inner of the two covers is made of white opal glass to furnish the proper background for the specimen. The outer cover is made of transparent glass beneath which the label is placed—thus insuring permanency of the label. Between the two covers is a space which is filled with the proper kind of sealing material.

Because of the space between the two covers this jar is slightly deeper than the jar in common use. Otherwise the dimensions are about the same.

Method of Mounting Eye Specimens in New Jar.

(Given in detail.)

1. Wash specimen as soon as possible, in ordinary tap water to remove blood.

2. Place in a 4% solution of formaldehyde (one part formalin to ten parts of water) for three days or longer, using preferably not less than two ounces of the fluid.

3. Cut eye in two with a sharp knife. This can be best accomplished by wrapping the eye in a piece of waxed paper and making the specimen rigid by freezing with ice (or better, ice and salt) after which the waxed paper is removed and the eye cut in two with a sharp long-bladed knife. It requires from two to three hours to freeze the eye properly.

4. Place the cut specimens in ordinary tap water to thaw.

5. Place specimens in 30% solution of glycerin (in water) for one day.

6. Change to 50% glycerin (in water)—one day.

7. Drain off excess of glycerin solution and place specimen (one-half eye) with convex surface downward in eye-jar.

8. Pour in glycerin-gelatin (previously prepared and again liquefied by gentle heating in a double boiler) filling the jar up to the level of the shelf on which the inner cover is to be later placed. The glycerin-gelatin is prepared as follows:—

- (a) Place one ounce best clearest gelatin (*Gold Label*) in eight ounces of hot distilled water.

- (b) When dissolved, add the beaten whites and shells of two eggs, place on water bath and heat gently with constant stirring until the coagulated albumin rises to the surface—leaving a clear liquid. Filter, while hot, through filter paper (preferably)

or absorbent cotton. (A preliminary passage through cheese cloth will remove the larger particles and facilitate filtration through the paper).

(c) Add to the filtered gelatin, an equal amount of pure clear glycerin and five drops of carbolic acid.

9. Turn eye specimen over by means of forceps—being careful that no bubbles of air are caught beneath the specimen.

10. Add 20 drops of formalin (40% formaldehyde sol.) to the gelatin after it has cooled somewhat, but while it is still liquid. Mix. This will prevent the reliquefaction of the gelatin.

11. Allow gelatin to “set”—being careful that the specimen properly retains its position in contact with the flat surface of the jar. Solidification may be facilitated by placing specimen in ice water. Remove bubbles from surface while gelatin is solidifying.

12. Fill jar with liquefied glycerin-gelatin and add five drops of formalin (40% sol. of formaldehyde). After the bubbles have come to the surface, but while the gelatin is still liquid, slide the inner cover (of white opal glass) in place on shelf of jar—being careful that no air is introduced beneath cover.

13. Let stand for 48 hours to permit gelatin to become fixed by the formalin.

14. Prepare label as follows:—

(a) Cut a circular piece of thick white smooth paper of size of inner cover.

(b) Write name of specimen, etc., with black India water-proof ink. Dry thoroughly.

(c) Fasten label on either side of outer cover (of clear glass) by means of mucilage. The labeled side of the paper should, of course, be toward the glass.

15. Remove all gelatin from jar above the inner cover, wipe the glass clear with a damp cloth.

16. Place specimen in ice water—being careful that the water does not extend beyond the level of inner cover.

17. Pour dish level full of marine glue (special), heated *just enough* to permit it to flow. (The marine glue should be heated in an iron ladle and kept well stirred).

18. Heat edge of dish and border of outer cover on labeled side carefully by means of a Bunsen burner, and apply cover to jar while hot. Press cover down firmly—squeezing out excess of marine glue.

19. Trim off excess of marine glue and smooth off with xylol

For the preservation of natural color, either the Kaiserling or the Delépine method may be applied in preparing the specimens and the final mounting medium.

The distinct advantages of the jar here described, over the jars now on the market, are that it insures:—

(1) permanency of the preparation; (2) neatness and permanency of the label.

The jar here described is manufactured by F. A. Hardy & Co., Chicago, Ill., U. S. A.

The marine glue used by us was obtained from Binney and Smith, 81-83 Fulton Street, New York, under the name of Hay's Light Marine Glue. It is also supplied by the maker of the jar.

A METHOD FOR OBTAINING SATISFACTORY SECTIONS OF TEETH WITH THE SOFT TISSUES IN SITU.*

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In preparing sections of teeth, two processes are in use. The macerated and dried tooth may be ground on wheels or between hones until of the required thinness, to demonstrate the hard parts; or the tooth and surrounding tissues may be decalcified, imbedded in celloidin, and sections cut to show the structure of the soft parts. The latter method is very unsatisfactory, for the dentin and enamel are so dense that either a very strong decalcifying agent must be used or its action must be unduly prolonged. In either case the result is the same. The cells become swollen and indistinct in outline, and lose their staining qualities to such an extent that fine details are completely lost. Moreover, the matrix left after decalcification is so dense and becomes so hard in the process of dehydration that sections of desirable thickness cannot be cut.

The method about to be described is based upon a principle developed by G. von Koch in 1878.¹ Tissues containing both hard and soft parts may be imbedded in gums of various kinds, and the different tissues may be thus rendered sufficiently nearly of the

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8, 1916.

¹G. von Koch, Zool. Anz., 1878, i, 36.

same consistency to allow the entire mass to be ground in the same manner as macerated tooth or bone.

This method has the advantages of preserving both hard and soft parts in their normal relationship and structure and of preserving the integrity and staining qualities of the cells. On the other hand, the process is slow, tedious, and uncertain, and but one section can be obtained from a block. The thinness of the section depends largely on the skill and care of the operator.

The process was robbed of its tediousness and of much of its uncertainty by G. V. Black² who invented an instrument for carrying on the grinding automatically. The instrument has as its base a watchmaker's lathe bed. Attached to the lathe head is a grinding stone surrounded by a spatter guard and supplied with a stream of ice water. The blocks of tissue to be ground are clamped to brass discs by means of a spider and dogs and then surrounded by thick balsam which is hardened in a paraffin oven. When sufficiently hardened the brass discs are screwed on to the end of a rotating shaft in the object carrier (which occupies the position of the tool rest in the original lathe) and the imbedded tissue is forced against the surface of the grinding wheel by means of a spiral spring. A complicated mechanism stops the driving motor when the section is thin enough.

We have modified the method of Black by using gum damar dissolved in benzol in place of balsam dissolved in xylol. This allows the blocks to be imbedded more rapidly, as the mass hardens much more quickly; moreover, the imbedding mass is more uniform in consistency, and its hardness is more readily controlled. The gum damar offers another advantage over balsam in that it does not tend to adhere to the wheel to the same extent as balsam, and tap water can therefore be used in place of ice water to keep it hard.

We have also modified greatly the apparatus of Black. For the mechanical improvements I am indebted to Mr. Kelsey, an instrument maker of Minneapolis. We have retained the same brass discs and imbedding apparatus. On the lathe head we use three grades of stones, a coarse and medium grade of carborundum or emery, and a fine Arkansas stone for the final polishing. Provision is further made for a wide latitude in the speed of grinding by means of a number of pulleys of varying sizes, and by using adjustable weights to obtain the proper degree of tension against the stone, instead of a spiral spring. In this way

² Dr. G. V. Black, *Special Dental Pathology*, Chicago, 1915.

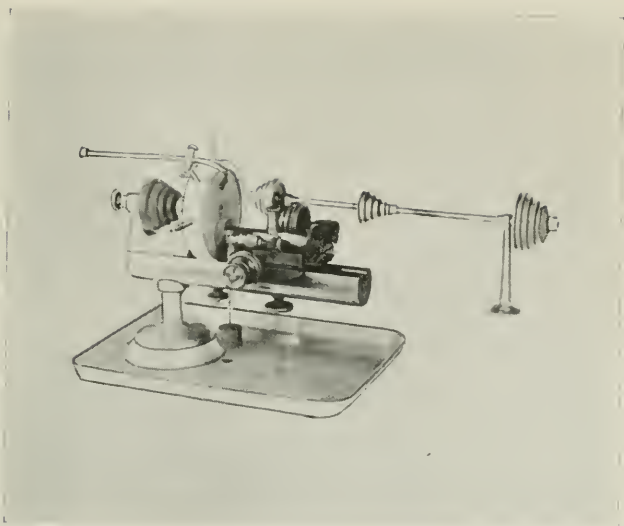


FIG. 1. APPARATUS FOR GRINDING SECTIONS OF TEETH AND JAW WITH THE SOFT TISSUES IN SITU. GENERAL VIEW.

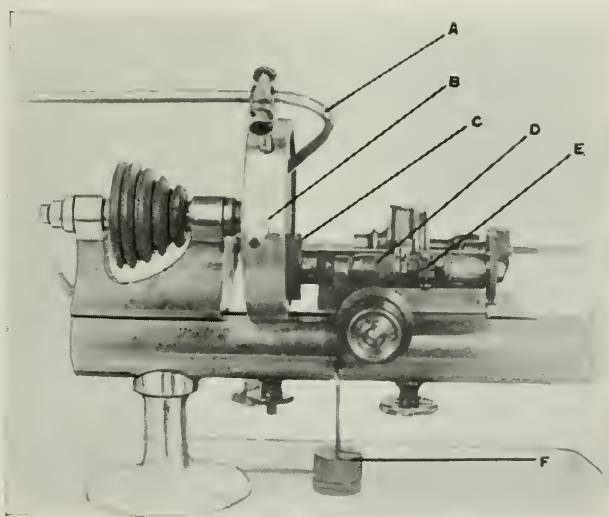


FIG. 2. CLOSER VIEW OF THE SAME.

A, pipe supplying the stone with flowing water. *B*, grinding stone and spatter guard. *C*, brass disc to which the tissue is cemented. *D*, the fixed arm, with micrometer screw. *E*, the adjustable arm on the object carrier. *F*, weights to provide tension.

*we can vary the speed of grinding from $\frac{1}{4}$ inch in 15 minutes in the first rough grinding to about .001 inch a day in the final polishing.

The automatic stop is also simpler. It consists of a fixed arm projecting from the lathe bed and provided with a micrometer screw reading in thousandths of an inch, and an adjustable arm projecting from the object carrier. The latter rides on ball bearings and is moved towards the lathe head by the weights through a cog and toothed rail. When the section has been ground to the thickness indicated on the micrometer, the adjustable arm strikes the fixed arm and prevents the object carrier from moving any further towards the wheel; the machine then runs idle and no further grinding occurs.

In practice, slices of jaw with the tooth in situ are imbedded in the manner described and ground rapidly until the tissue desired in the section is exposed, then polished on the fine stone. The block is then dissolved off in benzol, reversed on the disc and re-imbedded. It is then ground rapidly until a few thousandths of an inch thick, when a medium grade stone is used, the micrometer set at .001 of an inch and the grinding continued until the section is of that thickness. It might be desirable to obtain a larger micrometer reading in microns, but it would seem that .001 of an inch is the limit of safety for automatic grinding; for when the sections get much thinner than this they have a tendency to chip at the edges or tear loose from the disc; moreover, there is always present between the section and the disc a film of gum damar of unknown thickness. So, after the section is ground fairly thin, we grind very slowly on the finest stone and watch it closely. One learns to estimate the thickness of the section by its translucency. In this way we obtain sections 10 to 15 microns in thickness, and have in several instances obtained still thinner sections.

After grinding, the sections are dissolved off in benzol, run through the alcohols to water, and then treated in the same way as a frozen section. Histological details in the enamel, dentin, periodontal membrane, bone, and gums are retained well. The pulp shrinks badly and is usually torn loose in grinding.

MOUNTING SPECIMENS UNDER PETRI DISHES AND CLOCK GLASS.*

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Since obtaining a suitable cement for the sealing of square museum jars, the mounting of thin sections of pathological and anatomical specimens under Petri dishes and clock glass, has been made both easy and cheap.

Several years ago these mounts attracted a great deal of attention, being put on the market as paper weights, etc., but were gradually adopted for the exhibition and display of museum specimens. The method, however, being patented, was expensive and beyond the reach of the average museum, besides it was necessary to send the material for mounting to the manufacturer.

In 1906 Dr. Hutchinson, of the Royal Victoria Hospital, Montreal, read a paper before the British Medical Association at Toronto on this method; unfortunately he did not have a suitable cement and the process was slow and laborious.

METHOD.

The fluid used for mounting should be brought to a boil in the same dish that is to be used for mounting and allowed to stand over night or until cool, to get rid of as much air as possible. The dish should be deep enough to come well up over the mount to allow of both easy manipulation of Petri dish and specimen. Get a Petri dish of suitable size to hold the specimen so that when the sheet of glass which is to form the cover of the mount is in position it will not quite touch it.

Great care must be taken that the Petri dish or clock glass fits perfectly on the base and does not rock.

In placing the Petri dish in the mounting fluid do so without causing any air bubbles. When the dish and fluid are ready wash the specimen in several changes of the same fluid that you are mounting in, to get rid of any loose particles of dirt.

In the last change of fluid work out all air and remove quickly to the Petri dish, face downwards, again eliminating air bubbles.

* Presented at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

A small piece of looking-glass in the bottom of the mounting dish is very convenient, as by tipping the Petri dish over and on its side slightly, any bubbles under the specimen may be seen.

The specimen now being in position put on the base or cover and remove from the mounting-dish holding it firmly so that it cannot slip and admit air while turning the mount right side up.

Over the junction of Petri dish and cover pour hot cement¹ to the thickness of about one-quarter of an inch, and allow the mount to stand on a flat surface for a few days, or until the cement is perfectly adherent to both Petri dish and cover. If after several days it is desired to finish the mount, remove any bubbles of fluid between the cover and cement with a very hot knife, working the knife to the outer edge of the base. This must be carefully done and the knife kept hot enough so that the cement will be kept liquid and not be drawn away from the Petri dish. All the fluid must be removed from under the Petri dish in this way.

The best results are obtained, however, by allowing the mount to stand for several weeks when most of the excess fluid will work out by itself. I usually mount several dozen specimens at a time and let them stand until they are ready to finish. If any air bubbles should happen to get under the edge of the Petri dish they will have to be worked into the mount in the same way that fluid is removed, only the knife should be worked inwards instead of outwards.

Even with the greatest care air is often retained in the specimen itself, and only detected after the mount has stood for several days. Should the bubbles be very small they will quite frequently be absorbed by themselves, if not, shake the mount until they are all in one large bubble and resubmerge in mounting fluid, which must be heated as hot as you can comfortably stand your hand in. When the cement has become pliable enough so that it is possible to move the Petri dish with the fingers, insert the point of a sharp knife between the dish and base gently forcing them apart and allowing a little fluid to enter the mount which must be then tilted on its side to bring the air bubble to the opening where it will escape when you remove the point of the knife, and press the Petri dish up on to the base expelling all superfluous fluid. Close the hole by pressing the soft cement together with the fingers.

¹ See Muir and Judah,—Sealing of Museum Jars. Bulletin No. V, International Association of Medical Museums, page 87.

Air bubbles may have to be removed several times depending on the specimen: sections of lung, etc., give the most trouble.

When sure that there are no more bubbles in the mount and that all fluid has been removed from between the cement base and the Petri dish, coat the cement over to the thickness of about one-eighth of an inch with refined asphalt being careful that it does not burn. I usually melt it in a tea-spoon over a Bunsen burner. When the asphalt has been all applied, reheat the whole with a very hot knife or apply a bezel ring which must be heated red hot, and pressed down into the cement so that the lower edge will rest upon the base. Clean with gasolin and polish with *Bon Ami* soap.

The Petri dishes used are manufactured specially from 2 to 3 mm. thick, as the ordinary ones sometimes break with the expansion and contraction of the fluid. The bezel rings which are used to give a finished appearance to the cement can be made out of any metal that will stand being heated red hot. They are not, however, absolutely necessary, as you can use a sheet of cardboard with a hole cut in the centre and *patte partout* the edges. Dr. Higgins, of the Experimental Farm, Ottawa, has a very convenient cardboard case into which he slips the mount. If a bezel ring is to be used the base or cover should be made out of plate glass with the edges bevelled.

Clock glasses are inferior to Petri dishes for this method because they magnify and distort the specimen.

The following list of sizes has been found to answer all requirements. While 36 in number they require only ten different sized bezel rings and plate glass bases, a desired advantage when having glassware made to order.

SIZES—(OUTSIDE MEASUREMENT.)

SIZE NO.	WIDTH	HEIGHT
1	18 cm. x	3 cm.
2	18 cm. x	2 cm.
3	18 cm. x	1 cm.
4	16 cm. x	3 cm.
5	16 cm. x	2 cm.
6	16 cm. x	1.5 cm.
7	14 cm. x	3 cm.
8	14 cm. x	2.5 cm.
9	14 cm. x	2 cm.
10	14 cm. x	1.5 cm.
11	12 cm. x	3 cm.
12	12 cm. x	2.5 cm.

13	12 cm. x	2 cm.
14	12 cm. x	1 cm.
15	10 cm. x	2.5 cm.
16	10 cm. x	2 cm.
17	10 cm. x	1.5 cm.
18	10 cm. x	1 cm.
19	8 cm. x	2.5 cm.
20	8 cm. x	2 cm.
21	8 cm. x	1.5 cm.
22	8 cm. x	1 cm.
23	6 cm. x	2.5 cm.
24	6 cm. x	2 cm.
25	6 cm. x	1.5 cm.
26	6 cm. x	1 cm.
27	4 cm. x	2.5 cm.
28	4 cm. x	2 cm.
29	4 cm. x	1.5 cm.
30	4 cm. x	1 cm.
31	3 cm. x	2 cm.
32	3 cm. x	1.5 cm.
33	3 cm. x	1 cm.
34	2 cm. x	2 cm.
35	2 cm. x	1.5 cm.
36	2 cm. x	1 cm.

A MOUNTING FLUID FOR GROSS SPECIMENS IN THEIR NATURAL COLORS.*

OSKAR KLOTZ AND WM. H. COBURN, PITTSBURGH, PA.

(*From the Pathological Laboratories, University of Pittsburgh.*)

Two years ago we reported before this Association a method for fixation and preservation of colors in gross specimens. At that time our attention was concentrated upon the problem of devising a simple means for retaining the natural colors in tissues. We have, we believe, succeeded in this by using a modification of what is known as the Jores' method. The technic of the procedure was published in the Bulletin of this Association in 1915. The method then described had the advantage of being cheap, of ease of application and of giving brilliant color results in vascular

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8th, 1916.

tissues. With this fluid for fixation, there was little danger in overdoing the first stage of preserving colors in gross specimens, as is so often the fault of the Kaiserling method. Furthermore, we had the advantage of never losing sight of the color effects which were originally in the tissue and which it was desired to preserve. As you all know, with the Kaiserling method, the color often changes during the initial process and the original color effect must be returned by means of alcohol oxidation.

At the time of our last report we made use of a slightly modified Frost's fluid for permanently preserving the specimens. We used the same ingredients save the omission of sodium fluoride in the solution. Since this time we have studied the problem of the permanent preservation of tissues somewhat more closely. We still find that our primary fixation fluid meets the desires in every respect. We have adhered to the same formula as previously given. The general principle respecting any fluid, used as a fixative, applies to this solution and that is, that the tissue should, if possible, be cut into slabs not over 3 cm. in thickness. The slabs may be of any size in surface area as long as the containers used for their preparation are sufficiently large to permit hardening without folding. Organs of greater thickness may, nevertheless, be preserved but require a longer period in the fixing fluid.

We have found several short-comings with Frost's fluid which have led us to abandon it. It not uncommonly occurs that specimens accumulate in the museum preparation room more rapidly than they can properly be taken care of and mounted. Formerly while using the Kaiserling method we carried the specimens through the first two stages to solution number three where a number of specimens would occasionally be allowed to remain until an opportunity was had to mount in the final museum jars.

This we have also done when using Frost's solution. When, however, we returned to our specimens for demonstration, these materials were found extremely disagreeable to handle because of the stickiness of the concentrated sugar solution. The surroundings of the individual employed in mounting specimens in Frost's solution were always in a disagreeable state. The occasional leaking jar on the museum shelf, which under ordinary circumstances is a great annoyance, is doubly so when the leaking fluid contains so much sugar. Lastly the sugar solution has an undesirable effect upon the preserved tissues not unlike that which occurs with glycerin in Kaiserling number three. The tissues have a water-logged appearance and the colors gradually lose their

intensity. Another difficulty with the Frost's solution was the occasional moulding and fermentation of the fluid. This is extremely annoying when it occurs in specimens that have been mounted and sealed.

We have found that a preserving fluid containing the same ingredients as the fluid of fixation may be used for the final preservation of the specimens. This fluid is made up according to the following formula:

Carlsbad salts	2.5
Choral hydrate	1.0
Formalin	0.5
Water	100

The Carlsbad salts made up according to the National Formulary has been found very satisfactory. The method has been efficient in our hands, although the oldest mounts are now only about a year and a half old. Still in this time we have found far fewer failures than we have previously had with either the Kaislerling or the Frost's preservative fluid. The colors maintain their intensity and if properly fixed will not leak. The presence of the small amount of formalin has not shown any harmful effect upon the color of the tissue. The presence of the chloral hydrate appears to neutralize the reducing action of the formalin. There has been an absence of fermentation throughout. Finally the cost of materials is very much less than any of the other preservative fluids that we have tried. It is to be remembered that the successful preservation of gross specimens lies to a great extent in the proper fixation of the tissues prior to the final placing in the preserving fluid. Tissues which continue to leak color must be further fixed before placing them in the final containers and sealed.

On several occasions we have had necessity of returning to our preserved materials for obtaining tissues for microscopic section. We have been struck with the fact that the staining results have been unusually good. In fact, the sections obtained are better than plain formalin fixed tissues. This bears out the finding in other laboratories that formalin fixation is best done with a fluid containing various salts. Five per cent formalin in Ringer's solution gives much better results than the plain formalin dilution.

THE ROLE OF ORGANIC ACIDS IN THE PRESERVATION OF SPECIMENS.*

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University of Minnesota.)*

Like other laboratories we have been troubled with liquefaction of our gelatin mounts and fading of some of our other specimens mounted and preserved in fluid media.

Testing the acidity of the various media showed that not only was our formalin and glycerin acid before use, but that the acidity steadily increased when specimens were placed either in straight 10% formalin or finally in Kaiserling III solution. For example, pure formalin and glycerin showed acidity values (with phenolphthalein as indicator) ranging from 0.3 to 0.5 per cent, while a solution of 10% formalin which had been used to preserve a kidney for 17 years was 10.2% acid and a Kaiserling III solution similarly employed for 14 years had an acidity of 5.1%.

Investigations in regard to the character of this acidity showed the presence of formic acid. Other organic acids resulting from the decomposition of tissues are also undoubtedly present.

The problem is, then, to provide some neutralizing substance which will not injure the specimen, or cause a precipitate, and which will also perhaps have some buffer value in maintaining the solution neutral. Experiments are now being conducted with this end in view. Suggestions would be gratefully received.

A NEW METHOD OF PREPARING MUSEUM SPECIMENS.*

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*(From the Pathological Museum, George Washington University
Department of Medicine and Hospital.)*

In presenting this preliminary note, a new method of preparing specimens, old as well as new, is substituted for the well-

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, D.C., May 8th, 1916.

* Presented with series of illustrative specimens at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

known alcohol procedure of Kaiserling—a method which not only avoids the pecuniary disadvantages attending the use of alcohol, but which, from the point of view of color, also results in advantages. After considerable experimentation in an endeavor to find a satisfactory substitute for alcohol, the use of a saturated solution of sodium chlorid gave such striking results, not only in the extraction of the formaldehyd content from the freshly prepared specimen, but also in the restoration of color to old Kaiserling specimens, that the solution in question became an important part of the new system. Old tuberculous viscera which had lost so much of their color as to render the tubercles in the intestinal walls practically invisible were restored to their natural colors by an immersion, for a period of six days, in the saturated salt solution. An old and discolored lung (pleurisy), a kidney 11 years old, together with a miscellaneous collection of old Kaiserling specimens, were similarly treated with striking results.

While the use of the sodium chlorid solution proved of distinct advantage in the process of clearing the specimens and developing the gross colors, a study of the results revealed the possibility of a further evolution of color production by restoring the finer tints which had been lost in the gradual process of deterioration. Experimental procedures proved that a solution of potassium acetate and nitrate would produce, in conjunction with the saturated salt solution, the desired end-restoration of the finer tints. With new as well as with old specimens, the tests proved that in the preparation of museum specimens, the use of alcohol could be avoided. After a number of experiments, it was conclusively demonstrated that the formaldehyd extraction and subsequent color development were far more satisfactory when the procedures in question were effected by means of the saturated salt and nitro-acetate solutions than by the more expensive method of using one or more alcohols.

The system employed in the preparation of specimens for the Pathological Museum of the George Washington University Department of Medicine involves the use of the following solutions:

SOLUTION 1.

Liquor formaldehydi	200 c.c.
Potassium nitrate	15 gm.
Potassium acetate	30 gm.
Water	1,000 c.c.

SOLUTION 2.

Saturated solution of sodium chloride q.s.

SOLUTION 3.

Potassium acetate 60 gm.
Potassium nitrate 30 gm.
Water 1,000 c.c.

SOLUTION 4.

Potassium acetate 100 gm.
Glycerin, C. P. 250 c.c.
Water 1,000 c.c.
Liquor formaldehydi 5 to 10 c.c.

Depending on its size, the carefully washed fresh specimen is allowed to remain in Solution 1 for a period of from one to five days. With allowance for the extent of the pathologic changes as well as for the size of the specimen, formaldehyd extraction and gross color development are usually completed by Solution 2 in from one to three days. In Solution 3 (nitro-acetate solution) the time required for the complete development of the colors in the fresh specimen is from two to seven days, old specimens requiring, of course, a longer period of immersion. The specimen is then placed in the glycerin preservative fluid to which liquor formaldehydi is added to prevent the growth of moulds. In the preparation of solid viscera (kidney, liver, spleen, etc.), the color development of the deeper parts is of paramount importance. The best results will be obtained by placing the specimen directly in Solution 1 for a period of several days, at the end of which time it should be sectioned as desired and immersed (one or two days) in Solution 2. An immersion in Solution 3 for a period of from two to five days will complete the color evolution of the exposed surface of the sectioned specimen with a remarkable degree of perfection. In the preparation of old specimens, the Kaiserling-preserved viscus admits of a remarkable degree of color restoration by the use of Solutions 2 and 3. Old specimens should be placed in Solution 2 for a period of from two to five days, then in Solution 3 for a similar period of time. During the year in

which this method of preparing museum specimens has been tried, the results have proved eminently satisfactory. Daylight and direct sunlight have in no way affected the variety and brilliancy of the colors. Shrinkage of the specimens has not been observed and a crucial test—drying a specimen in the air for several days and recoloring with Solutions 2 and 3—has given excellent results in the recovery, not only of the form of the original, but also of the color differentiation obtained at the time of preservation.

Microscopic Technique

SOME SUBSTITUTES FOR GLASS FOR COVERING MICROSCOPICAL SECTIONS.*

I. GELATIN.

II. PYRALIN.

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(From the Pathological Laboratory of the University of Michigan, Ann Arbor, Mich.)

The difficulty in obtaining suitable cover-glasses, especially those of the larger sizes, during the past year, has emphasized the need for continued search for a substitute material. This, to be available, must be a substance which can be applied so as to form a thin protective covering over the section. It must be, also, practically colorless, transparent, permanent and of such optical properties as will permit the use of objectives intended primarily for viewing sections covered with glass. In regard to this last consideration it must be borne in mind that any material which will permit the use of low power objectives will still be very useful even if its optical properties are such that it is not well adapted to work beneath an oil immersion objective or in microphotography.

Although no substitute has been found which can in all respects take the place of glass for covering microscopical sections the two materials and methods presented here have proven adequate for certain kinds of work.

I. Gelatin. Very serviceable and permanent mounts of microscopical sections can be made by Nieuwenhuys's modification of Liesegang's method of mounting in gelatin. This method, as applied to single unfixed sections, has been described in Bulletin No. V of this Association. We have found it equally applicable to paraffin sections handled by dextrin or molasses fixative celloidin sheet method or when fixed to the slide by the albumin method. Its range of usefulness can therefore be extended to include the mounting of series of sections.

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8th, 1916,

The method is as follows: The sections after staining are transferred from water to a thick gelatin prepared by soaking 1 part best gelatin in 3 parts of cold water, raising the temperature to 50 degrees C and filtering. This gelatin solution is solid at ordinary temperatures but is liquid at 37 degrees C at which temperature it is used. The sections either in the celloidin sheet or fixed to microscopical slides are left in the warm gelatin in the incubator or drying oven for about twenty minutes. If the celloidin sheet method is being used, the celloidin should be cut into sections of the size desired for mounting before being placed in the gelatin. The glass slides, thoroughly cleaned, are then warmed by flaming and a few drops of the liquid gelatin placed upon each. The sections are then placed upon the slides letting them down upon the glass from one end in such a manner as to exclude air bubbles. A few drops of liquid gelatin are then placed upon top of the section and leveled off with a warm glass rod. The amount to be used depends upon the area to be covered. With a gelatin of the strength indicated above, about 1 cc. is required for every 5 cm.² Upon cooling, the gelatin becomes solid and is then put in 10% formalin for 30 minutes. The preparations are then dried at a temperature (about 30 degrees) below the melting point of the gelatin until the opaque moist layer is changed into a hard transparent film.

If the sections have been fixed to slides by the albumin fixative method, the entire preparation is immersed in the melted gelatin for the preliminary infiltration. The excess of gelatin is then drained off and the under surface and margins of the slide wiped clean with gauze dipped in warm water. A few drops of gelatin may then be placed directly over the section, if needed, and leveled with a glass rod, after which the method of procedure is the same as that for the celloidin sheet sections.

As Dr. Kappers has pointed out, this method not only does away with glass covers but also makes the use of alcohol, carbol-xylol, xylol and balsam unnecessary. The absolute freedom from stickiness even in the warmest weather is also a decided advantage. The chief disadvantage lies in the fact that stains readily soluble in water are either removed entirely or are diffused by the stay in the aqueous gelatin. With methylene blue, for instance, this method cannot be used. Very satisfactory results can be obtained with haemalum and eosin if the sections are properly washed in water before placing in gelatin so that the less firmly fixed portion of the eosin is removed. Another disadvantage is found in the length of time after staining before the prep-

aration is ready for examination, several hours being required for the drying out of the gelatin to the transparent condition. For permanent preparations, where large sections, or series or groups of sections treated as one in a celloidin sheet, are to be mounted, this application of Liesegang's gelatin method furnishes a very acceptable substitute for cover-glass and can be strongly recommended for that type of work.

II. Pyralin. In searching for a celluloid product possessing properties which would permit its use as a substitute for cover glasses, our attention was called to the Pyralin Sheeting manufactured by the Arlington Company, 725 Broadway, New York. This material may be obtained in sheets 20 x 50 inches in size and in thicknesses ranging from 5/1000 to 30/1000 of an inch. It is practically transparent and colorless, save for a slight smokiness scarcely to be detected in the thinner sheets. For use as a substitute for glass the material should be polished on both sides so that it is necessary to specify size of sheet, thickness, color and finish in order to secure the proper sort. With ordinary scissors, the sheets may be cut into rectangular pieces of the size desired. These rectangular pieces of pyralin may be employed in exactly the same manner as glass for covering sections, using balsam as the mounting medium. With lower powers of the microscope it is impossible to detect any difference as compared with glass and even the oil immersion can be used quite successfully. Xylol and balsam have no effect upon pyralin and the slips may be wiped off with xylol and used repeatedly. There is, of course, no loss from breakage in handling and cleaning, and the cost of covers cut from pyralin is but a fraction of that for glass.

There is, however, one important disadvantage. Mounts which are altogether satisfactory when first made show after a day or so a tendency for the pyralin cover to curl up somewhat at the edges with a resulting retraction of the balsam. This may be prevented to some extent by using a thick balsam, warming the slide before hand if necessary.

Aside from this one difficulty, pyralin sheeting makes a very satisfactory cover material for sections and can be fully recommended if permanent preparations are not desired.

A MODIFICATION OF MALLORY'S CONNECTIVE TISSUE STAINING METHOD.*

SAMUEL R. HAYTHORN, M. D.

(From The Wm. H. Singer Memorial Research Laboratory,
Pittsburgh, Pa.)

The combination staining method described in this report is recommended on the ground that it adds good strong brown-black nuclei to the already excellent differential picture obtained by the use of Mallory's aniline-blue connective tissue stain, and also because it insures a more constant orange-yellow color in the red cells than does the original method.

The method, as we are reporting it, has undergone many modifications in our hands during the past four years. It began with the ordinary staining of sections with haematoxylin prior to the use of Mallory's usual method, but this proved to be of little help as the nuclei were still very red. Heidenhain's over night haematoxylin method differentiated in iron alum was next tried and gave very satisfactory results save that the method was impractically long. It demonstrated however that the use of alum water mordanted the orange G, conserved the acid fuchsin and held back the deep aniline blue. This is a great advantage in the study of some conditions.

The method as given here is not difficult after a very little practice and gives almost constant results.

1. Fix thin blocks of fresh tissue for 24 hours in at least ten times as much Zenker's fluid as there is tissue. Wash 24 hours in running water, imbed and cut.

2. Bring sections to water.

3. Stain $\frac{1}{2}$ hour in Alum or Boehmer's Haematoxylin.

4. Rinse in water.

5. Mordant 2 minutes in the Alum-orange G solution *(a).

*(a) The alum Orange G solution must be prepared in the following way:

Dissolve 2 gm. of Orange G in

Alcohol 10 c.c.

Normal Hydrochloric Acid 1 c.c.

Water q. s. ad. 175 c.c.

When thoroughly dissolved, add

Saturated Iron Alum 75 c.c.

Total 250 c.c.

Filter

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

6. Place 5 minutes in tap water.
7. Stain 3 minutes in 0.5 Acid Fuchsin.
8. Blot off the excess of stain.
9. Stain 20 minutes in the modified Aniline Blue-Orange G solution *(b).

*(b) The modification of the anilin blue solution consists in the addition of $\frac{1}{2}$ gm. of Orange G powder to the original formula and complete solution obtained with the aid of heat. The modified formula is:—

Anilin Blue 2.5 gms.

Orange G 2.5 gms.

Sat. Phosphomolybdic q. s. ad..... 100 cc.

10. Differentiate by the drop bottle method, using 95% alcohol, absolute alcohol, and xylol. Mount in balsam. With this method the nuclei are stained deep black-brown; the red cells are brilliant yellow; the protoplasm dark red; fibrin and the various fibrils bright red; and collagen fibrils and amyloid pale blue.

When it is desirable to increase the intensity of the red and blue stains, it may be done by adding a slight amount of normal hydrochloric acid to the Orange G solution without changing the length of time in any of the solutions. This will, however, proportionately decrease the distinctness of the nuclei by causing them to take up more of the red stain. For this reason, it is the custom in our laboratory to prepare the Orange G formula in 250 cc. quantities and then take out 100 cc. and add to it an additional 2 cc. of normal hydrochloric acid and keep it separate for use on gliomata, fibromata, and leiomyomata, where the fibrils are of more importance than the nuclei. Otherwise the method as described has proven satisfactory.

SUGGESTIONS CONCERNING STAINING METHODS USED IN THE STUDY OF PATHOLOGIC LESIONS IN SYMPATHETIC GANGLIA.*

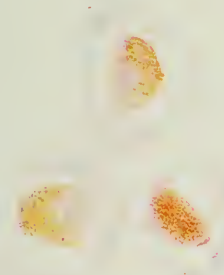
LOUIS B. WILSON, M.D.

Rochester, Minnesota.

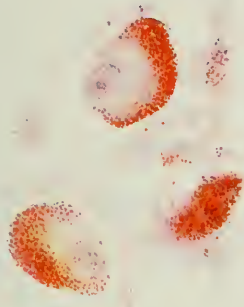
In reviewing the literature of the pathology of the sympathetic nervous system recently, I have been struck by the paucity of studies on the ganglion cells and by the fact that in the studies that have been made the tissues have been so rarely prepared by modern methods.

* Read before the International Association of Medical Museums, Washington, D. C., May 8, 1916.

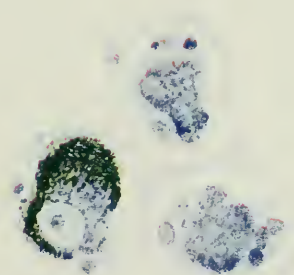
a
Faint
Hematox.
75687
10 μ Sec.
X 400



c
Faint
Hematox.
+ Sudan III.
75687
10 μ Sec.
X 400



b
Held-
Nissl
119713
10 μ Sec.
X 400



d
Ramon
y Cajal
75687
10 μ Sec
X 400

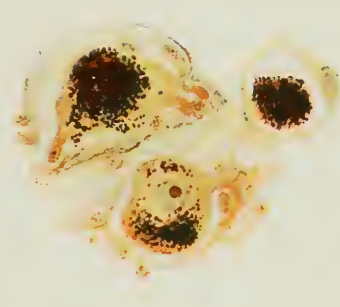


Plate I. Cervical sympathetic ganglia cells stained by various methods.

I wish to call attention here to some methods which it seems are not used by pathologists in the study of the autonomic nervous system, but which may give clear pictures of otherwise obscure lesions.

1. The cells of ganglionic tissue freshly removed from the living patient may be very well stained in frozen sections with polychrome methylene-blue, differentiated in salt solution, and mounted in Bruns' glucose medium.¹ The chromatin granules and the nuclei stain well. Changes in the size and shape of the cells are readily made out, and of course are free from the suspicion of artefacts due to embedding. If the sections are not too heavily stained, or if they are well washed out in salt solution, pigment granules, when present, show up very beautifully. The character of the cells of the stroma also may be clearly observed.

2. Frozen sections of fresh tissue, or of material recently fixed in formalin, when stained with Sudan III, followed by a feeble staining with Ehrlich's acid hematoxylin, show advanced fatty changes, if present, very satisfactorily. (Plate 1-c).

3. Luden's² modification of Weigert's method gives good color pictures for the comparative differentiation of lipoids.

4. Bensley's³ acetic-osmic-bichromate method for mitochondria gives not only a most satisfactory staining of these structures, but also other details of the ganglion cells, including the lipid granules.

5. Levaditi's⁴ method, exactly as used for the staining of spirochetes, may be applied to formalin-fixed material, and will usually give strikingly beautiful results. For young human tissues and for tissues from experimental animals (dogs, goats, rodents), however, it is not so good as Method 6.

6. The most satisfactory of all methods for the study of advanced changes in ganglionic cells are the various modifications of Ramon y Cajal's⁵ 1910 silver impregnation methods. These

¹Wilson, L. B.: A method for the rapid preparation of fresh tissues for the microscope. *Jour. Am. Med. Assoc.*, 1905, xlv, 1737.

²Luden von Heumen, G.: Ueber die Anwendung meiner neuen schnellen Weigert-Modifikation für Paraffinschnitte. *Centralbl. f. all. Path. u. path. Anat.*, 1912, xxiii, 385-94.

³Bensley, R. R.: Studies on the pancreas of the guinea pig. *Am. Jour. Anat.*, 1911-12, xii, 308.

⁴Levaditi, C.: Sur la coloration du spirochaeto pallida Schaudinn dans les coupes. *Compt. rend. Soc. de Biol.*, 1905, lix, 326.

⁵Ramon y Cajal: *Trabajos des Lab. de Investigaciones Biologicas*, 1910, viii. *Rev. trimestral micrografica*, xiii.

are applicable to all changes of human tissue and to all of the ordinary experimental mammals. For human sympathetic ganglia, our best results have been obtained with a modification of Ramon's formula 4A:—

Tissue, well fixed in 10 per cent. formalin, is placed for 24 hours in 95 per cent. alcohol with one drop of ammonia to each 10 c.c. of alcohol. It is then wiped off with blotting paper, and silvered for five days in the oven at 38° in 2.5 per cent. silver nitrate solution. It is then washed quickly in water, and developed for two days in Ramon's pyrogallic developer, consisting of pyrogallic acid 5, formalin 5, and water 100. The tissues are then embedded in paraffin, cut and mounted in balsam. (Plate 1-d). For tissues from the goat, better results were obtained by increasing the strength of the silver nitrate solution to 5 per cent.

7. Bielschowsky's methods are similar to Ramon's, but in our hands have not given as good results on the ganglionic cells. They are of greater value, however, in the study of nerve fibers.

THE STAINING OF SPIROCHAETA PALLIDA IN TISSUES.*

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The demonstration of the presence of *Spirochaeta pallida* in tissues has come to be the conclusive criterion of the existence of a syphilitic infection. My own researches have shown that the presence of this parasite in the tissues occasions in the great majority of cases very slight parenchymatous atrophy and degenerations, and interstitial collections of lymphocytes and plasma-cells, with fibroblastic proliferation. The degree of these lesions is usually too slight to cause them to appear above the clinical horizon; but the tendency in these clinically cured or unsuspected cases is to run a very chronic, more or less latent, course, lasting from ten to thirty years, the ultimate results of which are parenchymatous atrophy and fibrosis with a corresponding loss of function, so that years after the initial infection, the patient appears clinically as a case of myocardial weakness, aortitis, chronic pancreatitis, diabetes, chronic nephritis, etc.: or simply shows vague and apparently inexplicable headaches, impotency, anaemia, cachexia, psychoses, etc. The pathologic interpretation of such

*From the Pathological Laboratory of the University of Michigan.

chronic cases as latent syphilitic infections due to the presence of the spirochetes, and the demonstration of these organisms in the slight lesions in the tissues of such cases is one of the most important and far-reaching advances made in pathology. The pathology of syphilis must be rewritten; the *gumma* must be relegated to the background as a pathognostic criterion of the existence of syphilis; and important changes must be made in our ideas concerning the frequency of this infection, its treatment and its curability.

Since the diagnosis of syphilis rests wholly upon the demonstration of the spirochete in these latent cases, the methods of staining this organism become of very great importance. What can be more impressive than well-stained sections showing the tissues crowded with innumerable spirochetes;—particularly when we recall to mind that only a decade ago we looked into syphilitic tissues and saw nothing. All has been changed by the development of *staining methods*, particularly one—the method of Levaditi. I do not know of any more important and far-reaching single advance made in medicine during the last decade than this single technical procedure. Yet experimental researchers often look with a self-assumed superior righteousness and a slight contempt at the worker in technical methods and pathological histology. Have the former any victories of achievement comparable to the discovery of the spirochete of syphilis?

The diagnostic importance, therefore, of the spirochete makes all staining methods designed to show it worthy of careful trial and consideration. Relatively few methods have been developed during the decade of work with this organism; and of these only one is, in my opinion, a good method considered from all points of view. In my laboratory during these ten years we have tried out all staining methods that have been applied to the demonstration of the spirochete; and I believe that a summary of our experience will be worth while. These methods are as follows:—

I. STAINING METHODS DESIGNED TO DEMONSTRATE THE SPIROCHETE IN SINGLE SECTIONS OF TISSUE.

1. *Schmorl-Giemsa Method.*

1. Fix in 10 per cent formol. Cut very thin sections on freezing microtome.

2. Place the sections in a staining dish containing a measured amount of distilled water. To each cc. of water add one drop of Giemsa's stain. Use clean glass needles to manipulate

the sections. After one hour transfer sections to a fresh solution in which they are left 5-12-24 hours.

3. Wash quickly in a concentrated solution of potassium alum, then quickly in water.

4. Mount in glycerin-gelatin; dry on the slide until nearly dry; blot with xylol or cedar oil and mount in xylol or cedar oil or neutral balsam. Do not use alcohol.

The spirochetes are stained pale lilac or reddish violet and can hardly be distinguished from the deeply stained background.

Various modifications of the staining of spirochetes in sections by means of Giemsa's stain have been suggested, but in all of these the spirochetes are stained so lightly that the methods have but little practical value. Rarely is it possible to photograph spirochetes in sections stained with this stain. In many cases the organisms do not stain at all; so that the failure to obtain spirochetes by this method does not in any way mean that the organisms are not present in the tissues.

2. *Nikiforoff's Method.*

1. Fix for 24 hours in equal parts of a five per cent water solution of potassium bichromate and a saturated solution of mercuric chloride in 0.6 per cent sodium chloride.

2. After-harden in graded alcohols in the incubator.

3. Imbed in paraffin.

4. Stain 24 hours in a mixture of alcoholic one per cent solution of tropaeolin, 5 cc., concentrated watery methylene-blue solution, 10 cc., and caustic potash (1:1000), two drops.

5. Wash in water.

6. Dip several times in a mixture of equal parts of absolute alcohol and ether.

7. Oil of bergamot; xylol; balsam.

This method is also unsatisfactory and of no practical use. The spirochetes are often not stained, and when stained are barely visible.

In general I would say that no satisfactory staining of *spirochaeta pallida* in tissue-sections can be obtained by any of the aniline dyes.

II. SILVER-IMPREGNATION OF SECTIONS OF TISSUES.

Ferguson-Bielschowsky Method.

1. All methods of fixation applicable.

2. Imbed in paraffin. Fix sections on slide with albumin fixative.

3. 12-24 hours in a two per cent solution of silver nitrate.
4. Transfer for 15-30 minutes to a freshly prepared alkaline silver solution (20 cc. of a two per cent silver nitrate solution to which are added three drops of a 40 per cent caustic soda solution, and the precipitate redissolved by adding ammonia drop by drop while stirring).

5. Rinse quickly in distilled water; then place in 20 per cent formalin for three minutes or until the sections are black.

6. Wash in distilled water, and place for ten minutes in an acid gold bath (10 cc. distilled water to which are added 2-3 drops of one per cent gold chloride and 2-3 drops of glacial acetic acid).

7. Immerse in five per cent hyposulphite $\frac{1}{2}$ -1 minute to remove all unreduced silver.

8. Wash in distilled water; dehydrate; clear in xylol; mount in balsam.

This method stains both reticular fibers and spirochetes deep grayish brownish black, according to the degree of toning which can be varied to taste. With this method there is, therefore, no differentiation from reticulum as far as staining effects are concerned; and the recognition of the spirochete must rest upon purely morphological features. For an expert worker with the organism this is a safe procedure; but for the novice it would not be safe without control. The method has, however, the great advantage of being applicable to any fixation, economical in time, and applicable to single sections.

III. THE LEVADITI METHOD AND ITS MODIFICATIONS.

1. *Levaditi's Method.*

The original method of Levaditi gives the most successful staining of the spirochetes of syphilis in tissues. If the method is followed in the most painstaking manner, and if the following conditions are observed it will in the hands of an experienced worker give most beautiful and constant results.

1. The tissues must be fresh, and fixed immediately after removal from the body. Spirochetes rapidly disappear from the body after death. Evaporation, cold, excessive moisture, beginning putrefaction, etc., all affect the staining power of this organism. In tissues removed from the body and allowed to stand 6-8 hours or more without fixation the spirochetes are found clumped, beaded, fragmented, devoid of coils, slightly wavy, etc.

2. The formol used must be neutral, free of tannin, formic acid or vegetable coloring matter. The formol solution should be

made preferably in a physiologic salt, or Ringer's solution. The formol may be neutralized by adding powdered marble or calcium carbonate to the stock bottles.

1. Fix thin pieces of tissue (3-4 mm.) in 10 per cent neutral formol solution for 24 hours. Formol-Müller's and alcohol fixation may also be used but the results with these fixations are more uncertain.

2. 24 hours in 90 per cent alcohol.

3. In distilled water until tissue sinks.

4. Impregnation in incubator in a 1.5-3 per cent silver nitrate solution for 3-6 days.

5. Wash in the dark in distilled water for 15-30 minutes.

6. Reduce for 48 hours, in the dark, at room-temperature, in a solution of pyrogalllic acid 4 gms., 40 per cent formol 5 cc. and distilled water 100 cc.

7. Wash in distilled water thoroughly. Imbed in paraffin. Cut very thin sections. Toluidin-blue or Giemsa may be used as a contrast stain.

The spirochetes are dark brown to black against a yellow background. If properly managed the reticulum will be yellowish and not resemble the spirochete in staining quality. If carelessly managed silver precipitates will be found around the borders of the block, or even entirely through it, and the reticulum or even the entire section may be uniformly black. Experience is needed to gain perfect control of the method. In a well-prepared section the black spirochetes contrast well against the yellow background, and no contrast stain is necessary. In sections of brain or spinal cord a yellow background is obtained with greater difficulty because of the impregnation of fine neuroglia and nerve fibers by the silver. Careful manipulation of the method can, in expert hands, give sections in which the fibers and spirochetes are well differentiated. The longer the tissue is fixed in formol, the greater the impregnation of the spirochetes and the less that of the fibers. If fairly thick pieces of tissue (5 mm. and over) are used the spirochetes in the central portion of such pieces will be found to be more deeply impregnated than the neuroglia fibers.

2. *Levaditi's Pyridin Method.*

1. Fix thin pieces of tissue 24 hours or longer in 10 per cent formol.

2. 24 hours in 95 per cent alcohol.

3. Distilled water until tissue sinks.

4. Impregnation at room-temperature for 2-3 hours, and in incubator at 50-55°C. for 3-5 hours in the following solution:

1 per cent silver nitrate solution 90 cc.

Purest pyridin 10 cc.

5. Without washing, transfer directly to the following:

4 per cent pyrogallie acid solution 90 cc. } 85 cc.

Pure acetone 10 cc. }

Purest pyridin . 15 cc.

Reduce in this solution 6-9 hours.

6. Wash for 2 hours in several changes of distilled water, or until the odor of pyridin is entirely lost.

7. Dehydrate in water-free acetone or alcohol, clear in xylol, imbed in paraffin, and cut sections 2-3 microns thick.

It is essential that all solutions should be absolutely clean and filtered into the bottle containing the tissues. Our experience with this method has been much less satisfactory than with the original method, so that we no longer use it.

3. *Noguchi's Modification for Nerve-Tissues.*

1. Fix brain in 10 per cent formol.

Take pieces 5-7 mm. thick.

2. Leave these pieces 5 days at room-temperature in the following:

Formol 10 cc.

Pyridin 10 cc.

Acetone 25 cc.

Alcohol absolute 25 cc.

Distilled water 30 cc.

3. Wash in frequently changed distilled water 24 hours.

4. After-harden for 3 days in 96 per cent alcohol.

5. Wash in frequently changed distilled water for 24 hours.

6. Impregnate in a 1.5 per cent silver nitrate solution in a dark flask for 5 days at room-temperature or for 3 days at 37°.

7. Wash 2 hours in distilled water.

8. Reduction in a 4 per cent pyrogallie acid solution in a 5 per cent formol, for 24-48 hours at room temperature.

9. Wash thoroughly in distilled water.

10. 80 per cent alcohol for 24 hours.

11. 96 per cent alcohol for 3 days, changing several times.

12. Absolute alcohol for 2 days.

13. Imbed in paraffin.

Sections should be taken from different depths of the block in order to find the zone in which there is the best differential im-

pregnation of the spirochetes and fibers. In such areas the spirochetes should be black against a yellowish or yellowish brown background. In our experience, however, no better results have been obtained by this method than by the original Levaditi, provided that the tissues have been properly fixed in formol and after-fixed in alcohol.

4. *Nakano's Modification of Levaditi's Method.*

1. Fix thin pieces in 10 per cent formol 10-20 minutes at 37°.
2. After-harden 3-5 hours in 95 per cent alcohol.
3. Wash in running water 10 minutes, then 10 minutes in distilled water.
4. Impregnate in a 1.5 per cent silver nitrate solution in dark flask, for 4-5 hours at 50°.
5. Reduce in a 4 per cent pyrogalllic acid in 5 per cent formol solution for 4-10 hours at 50°.
6. Wash in water.
7. Imbed in paraffin.

This abbreviated Levaditi is not to be recommended, as the results are very uncertain.

5. *Yamaota's Modification.*

1. Fixed as desired. Take thin pieces (5 mm.), wash 24 hours in running water, and 1 hour in distilled water.
2. Impregnation in 5 per cent silver nitrate solution 48 hours at 37°.
3. Reduce 24 hours at 37° in the following mixture:

Tannic acid	1
Pyrogalllic	2
Distilled water	100

Change fluid if it becomes cloudy.

4. Wash 1 hour in water.
5. Imbed in celloidin. Counterstain with Löffler's methylene blue. Clear in origanum oil. Balsam.

Only the spirochetes are impregnated; and very good results can be obtained by this method. The failure at any time to obtain spirochetes cannot be taken as a positive evidence that they are not present.

6. *Eyene's and Sternberg's Modification.*

1. Thorough fixation in 10 per cent formol. Cut on freezing microtome, or imbed in celloidin.

2. Wash sections in distilled water, and place them in a 1 per cent silver nitrate solution 30-35 minutes in the incubator in the dark, or longer at room temperature in the dark.

3. Place sections in the following until they become dark (1-2 minutes). Remove before a precipitate occurs:

2.5 per cent silver nitrate	10 cc.
10 per cent aqueous gelatin (warm) ...	10 cc.
50 per cent aqueous gum Arabic	10 cc.
5 per cent aqueous hydroquinone	5 cc.

Mix well, adding the hydroquinone after the others have been thoroughly mixed.

4. Wash 1-2 minutes in a 10 per cent aqueous solution of sodium hyposulphite.

5. Wash in water, dehydrate, clear and mount.

Because of the excessive precipitates usually produced, this method is of little value to the ordinary diagnostician. As with most of the silver-impregnation methods improvement in results follows familiarity with the method.

Conclusion.—For the demonstration of the *Spirochaeta pallida* in tissues the silver-impregnation method of formol-fixed tissue according to the method of Levaditi offers the best results, and in expert hands becomes an almost perfect method. It can be readily seen that the essential features of the method,—fixation, impregnation and reduction,—offer a wide range of variation and modification, and that the individual worker will modify these factors until he secures the results that to him seem most reliable and satisfactory. In the writer's experience the following modification seems to be the best of all:

7. Warthin's Modification of the Levaditi Method.

1. Tissues must be as fresh as possible. Fix while warm, if possible. Blocks should not be more than 5 mm. thick.

2. Fix 3-10 days in the following:

Sodium chloride	0.9
Sodium bicarb.	0.01
Potassium chloride	0.02
Calcium chloride	0.02
Formol	10 cc.
Distilled water	100 cc.

The formol must be colorless and free from tannic acid. A perfectly neutral 10 per cent formol solution may also be used for fixation. The longer the formol fixation, the better the silver-impregnation will be.

3. Wash in frequently changed distilled water 24 hours.
4. After-fixation in 95 per cent alcohol for 3 days.
5. Wash in frequently changed distilled water 24 hours.
6. Impregnation in 2 per cent silver nitrate solution, in the dark, in the incubator for 3 days.
7. Wash thoroughly in distilled water, in the dark.
8. Reduce for 48 hours, in the dark, at room temperature, in the following:

Pyrogallie acid	4 gm.
Formol	5 cc.
Distilled water	100 cc.

9. Wash thoroughly in distilled water.
10. 80 per cent alcohol 24 hours followed by 95 per cent, and absolute.
11. Imbed in paraffin as usual. Cut thin sections. Counter-stains not useful.

Spirochetes are dark brown to black against a pale yellowish background. If the method is carefully followed there will be no precipitates. Especial attention should be paid to thorough washing and to impregnation and reduction in the dark.

Medical Research

THE CYTOLOGY OF NORMAL GOATS' BLOOD.*

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These observations on the cytology of normal goats' blood are intended as an introduction to studies on the pathologic changes occurring in the blood of goats under certain experimental conditions. I report them herewith that they may furnish data for other workers in this field of research.

The blood of goats does not appear to be a popular subject with hematologists. In literature dealing with the cytology of the blood of animals less than a dozen publications will be found containing data on the blood of goats. In every instance the total number of red corpuscles and white cells alone seems to have been considered worth recording. Differential counts for the blood of normal goats do not seem to have been made, although the pathologic changes following splenectomy have been reported by Warthin.¹

TOTAL ERYTHROCYTE AND LEUKOCYTE COUNTS.

A detailed summary of the total number of erythrocytes and leukocytes found by Malassez², Hayem³, Storch⁴, Mohler and

* Read before the American Section, International Association of Medical Museums, May 8, 1916, Washington.

¹ Warthin, A. S.: The changes produced in the hemolymph glands of the sheep and goat by splenectomy, hemolytic poisons and hemorrhage. *Jour. Med. Research*, 1902, vii, 435-63.

² Malassez, L. C.: *Compt. rend. Acad. d. sc.*, 1872. Quoted by Storch, l. c.

³ Hayem, G.: *Du sang et de ses altérations anatomiques*. Paris, Masson, 1889. Quoted by Storch, l. c.

⁴ Storch, A.: *Untersuchungen über den Blutkörperchengehalt des Blutes der landwirtschaftlichen Haussäugethiere*. Karlsruhe, Machlot, 1901.

Washburn⁵, Wells and Sutton⁶, Warthin¹ and Mann⁷ is given in Table I.

In comparing the figures in this table it should be remembered that the number of the red cells is subject to variations according to the age, the sex and the breed of the animals used for the counts. Malassez (total 19 million) and Hayem (18 million) do not mention these three factors in their report; Storch (kids, 10 million; males, 15 million; females, 13 million) has considered them very carefully, but his data refer to native Swiss goats (the smooth-haired type) and the influence of climate and altitude may have to be taken into account in contrasting them with Mann's observations (males, 16 million; females, 17 million) made on animals of a similar type (*Capra hircus*).

The average of 9 to 10 millions reported by Mohler and Washburn for Angora goats would appear somewhat low compared with an average of 14 millions mentioned by Wells and Sutton and the total of 13 and 18 millions observed by me in two animals (adults; 1 male, 1 female) of the same breed, although it is well known that there is a marked difference, not only in appearance but in constitutional hardness between the Angora and *Capra hircus*, or common goat, the Angora being much more sensitive to outward conditions.

Storch's conclusions that the total number of erythrocytes runs higher in males than in females of the same species, and that kids have a lower average than adult animals do not seem to be corroborated by the findings of Mann and Wells and Sutton. It must be remembered, however, that Storch's observations were made on a variety of *Capra hircus* whereas Wells and Sutton studied Angoras. Moreover, Mann's counts (Table II) clearly show that differences of 4 to 5 millions may be found in one and the same animal within a few days. The range in the total number of red corpuscles from 10 to 25 millions in apparently normal goats suggests that experimental observations based on erythrocyte counts may be extremely deceptive, even when the possibility of technical errors (due to smallness of the red cells and

⁵ Mohler, J. R., and Washburn, H. J.: Takosis, a contagious disease of goats. U. S. Dept. of Agric., Bur. of Animal Indus. Washington, 1903. Bull. No. 45.

⁶ Wells, J. J., and Sutton, J. E.: Blood counts in the frog, the turtle and twelve different species of mammals. Am. Jour. Physiol., 1915, xxxix, 31-36.

⁷ Mann, F. C.: Unpublished data.

the fact that they may be crowded together in the counting chamber even when a dilution of 1:200 is used) has been eliminated so far as possible.

The total leukocyte count in goats presents neither the technical difficulties nor the resulting element of error mentioned above, yet the figures in Table I show that variations from 6,000 to 18,000 in the number of white cells occur within normal limits. Consequently observations on leukocytosis and allied conditions brought about experimentally are apt to result in erroneous conclusions.

DIFFERENTIAL COUNTS.

Differential counts on the contrary appear to furnish constant and reliable data.

Our observations on the differential counts in normal goats will be found in Tables III to X and may be divided into two groups:

Group A: weekly counts of six normal goats over a period of five to seven weeks.

Group B: daily counts of two goats taken during two weeks.

The total number of counts made was fifty-one; in every instance 200 cells were counted, the total number of cells that came under observation being 10,200. In addition, differential counts were made for a number of animals not belonging to our series. These, however, have not been recorded in the tables either because the animal had been used for some experiment, and for that reason its blood could no longer be safely considered "normal," or because it died or was sacrificed after only a few counts had been made. In either case, the data obtained were too meager to be considered conclusive, though it should be stated that the differential counts of these animals were not found to differ materially from those recorded in our tables.

TECHNIC.

Three blood smears were used for each count. The smears were made on slides in preference to cover-slips for several reasons: (1) It was found advisable to write the number of the animal and the date of counting on each slide to prevent confusion while staining and for future reference; (2) the "slide-method" obviates the use of Canada balsam, which cannot be dispensed with if coverslips are used and which has a tendency to destroy

the color of anilin dyes and (3) owing to the war, coverslips could not be procured in sufficient numbers.

The blood-smears were stained by the Jenner, the Harlow-Hayhurst and the Pappenheim methods, additional slides being stained at intervals with the Leischmann stain for the sake of comparison. As has been stated, a differential count of 200 cells was made uniformly, the result being expressed in per cent to permit of an easy comparison with the current clinical data on blood counts. Special attention was given to the fact that the smaller types of cells (small lymphocytes, normoblasts) showed a tendency to congregate at one end of the slide (presumably because of their specific gravity), whereas greater numbers of the larger types were generally found at the opposite end. In order to minimize this factor of error as much as possible several areas were counted on each slide, the total count of 200 cells being made from three slides each time.

TERMINOLOGY.

Ehrlich's terminology has been used in all our counts, but the various types of leukocytes have been recorded in sequence of their relative numerical frequency. Although this classification cannot be considered correct from a hematologic point of view, it is generally found in clinical reports and has been adopted to facilitate the comparison between our data and clinical observations. For the same reason the term "polymorphonuclear" has been retained in preference to the term "amphophile" used by Kanthack, Bunting and Warthin for animal counts. According to Brinkerhoff and Tyzzer⁸ the amphophile leukocyte in rabbits "is the equivalent of the neutrophile leukocyte of human blood"; in normal goats' blood it is indistinguishable from the human polymorphonuclears when stained with azur-dyes. The exact staining reaction of the granules found in the polymorphonuclears of the goat will be determined later, for though these granules take a bluish tint in the Jenner, and the Harlow-Hayhurst stain similar to that found in the human cell under similar conditions (a purplish-brown tone being seen in slides stained according to the Pappenheim or the Leischmann method for both species), the color reaction may not be truly "neutrophile" in character. Until the nature of the granules has been definitely established (the investigation had to be postponed on account of the scarcity of his-

⁸ Brinkerhoff, W. R., and Tyzzer, E. E.: On the leucocytes of the circulating blood of the rabbit. *Jour. Med. Research*, 1902, vii, 173-89.

tologic dyes), it seems permissible to employ the term "polymorphonuclears" since it is often used in clinical literature for this type of cell and would therefore make a comparison more convenient between the changes observed in goat's blood under experimental conditions and in human blood under certain conditions of disease.*

The words "transitionals" and "atypical lymphocytes" in our terminology require a few words of explanation. "Transitional" has been used deliberately in preference to "large mononuclear" as the cells of this type found in normal goat's blood invariably belonged to that subdivision of the mononuclears called "transitionals" by Ehrlich, Grawitz⁹, Karl Schleip¹⁰, Leischmann, Meyer and Rieder¹¹ and others: that is to say, the cells in question all answered the following description¹²: "these cells resemble in a general way, the preceding (large mononuclears), but are differentiated from them by a large indentation of the nucleus, which frequently gives it the form of a wallet, by a somewhat greater affinity of the nucleus to nuclear dyes, and by the presence of a number of neutrophile granulations in the protoplasm". The typical mononuclears "with a large, oval, usually eccentrically situated and feebly staining nucleus, and a relatively large amount of protoplasm"¹² began to appear only at a later period together with other pathologic changes which will be discussed in another

* Since sending this communication to print the following statement has been received from Prof. Hal Downey, Minneapolis, whom the writer had consulted upon this point:—

"It seems to me that you will be quite safe in calling the polymorphonuclear leucocytes 'neutrophils.' They certainly show the specific reaction with triacid, although their poor staining in Wright's stain (Romanowsky mixture) shows that they are not chemically identical with the granules of the human polymorphonuclears. However, they are sufficiently close to them to be included in the same classification. I see only one type of those cells in the goat's blood. Eosinophils and mast cells seem to be about the same as those of human blood."

⁹ Grawitz, E.: *Klinische Pathologie des Blutes*. Leipzig, Thieme, 1911, p. 214.

¹⁰ Schleip, K.: *Atlas der Blutkrankheiten nebst einer Technik der Blutuntersuchungen*. Berlin, Urban & Schwarzenberg, 1907, p. 30.

¹¹ Meyer, E., and Rieder, H.: *Atlas der klinischen Mikroskopie des Blutes*. Leipzig, Vogel, 1907, p. 21, 31, 33.

¹² Ehrlich, P., and Lazarus, A.: *Anemia*. *Histology of the blood, normal and pathologic*. Nothnagel's Encyclopaedia of Prac. Med. Phila., Saunders, 1905, p. 66, 65, 70.

article, and it was therefore considered advisable to reserve the term "mononuclear" for these cells in particular.** The term "atypical lymphocytes" is merely descriptive. The cells referred to are slightly larger than red corpuscles, do not show any trace of protoplasm and possess a strong affinity for all nuclear dyes. The entire mass of the cell appears to be composed of coarser and finer basophilic granules—occasionally a few granules take a slightly reddish tinge. Considering this total absence of protoplasm, they do not seem to belong to the so-called "small neutrophile *pseudo*-lymphocytes", described by Ehrlich and Lazarus¹², as these authors state that the latter possess "a small amount of protoplasm studded with neutrophile granulations" and that "the small amount of protoplasm, and the small size of the cell itself, prevent confusion with small myelocytes". The distinctly granular character of the entire cell-body and the fact that stages of transition between these cells and the small lymphocytes could be repeatedly observed make it seem probable that they are the "bare" nuclei of small lymphocytes which according to Downey have been "stripped of their protoplasm by some unknown cause"; their granular appearance and affinity for basic dyes "being accounted for as due to pyknotic changes occurring in the nuclei themselves."*** These atypical lymphocytes were not found in the counts of the six normal goats (Group A), but increased in numbers as the blood picture began to show pathologic changes. It will be noted, however, that these cells do occur in Group B (Angora goats). As the blood smears of these counts were made after a spell of intensely cold weather and also as chemical changes (i. e., a slight increase of the cholesterolin value) were observed in the blood of our animals during this period, it is possible that some slight disturbance of metabolism due to the cold may have been responsible for the appearance of the abnormal cells in an otherwise normal blood picture. All the goats appeared to be in perfect health at the time.

MORPHOLOGY.

There is little to be said about the general morphology of blood cells in normal goats. It is well known that the red corpuscles are much smaller than those found in man, the average

** The descent and ultimate fate of transitionals and mononuclears will not be taken into account in this paper as it is intended for experimental purposes only and does not aspire to dealing with hematology as a science, especially since, according to Grawitz, "no two hematologists so far have been found to agree on the question."

*** Personal communication.

size given by Ellenberger¹³ being $4.1\ \mu$. (Human type, average size $7.0\ \mu$). Poikilocytosis and anisocytosis are often observed in apparently normal animals, but to a certain extent may be due to the inevitable crowding together of the corpuscles. The only cell differing materially from the corresponding cell-types seen in human blood is the normoblast. Its characteristics are those of a basophilic nucleated corpuscle. With the Pappenheim stain it assumes a tint of intense dark blue comparable to the "Prussian blue" in water-color. The edge of the cell stains somewhat lighter and has the appearance of being slightly curled up. Occasionally there are found on this edge a few tiny granules which are gold-brown in color and appear to be a part of the cell. The shape of the normoblast is usually round, but oval forms also may be found.

The leukocytes, as has already been stated with reference to the polymorphonuclears, are indistinguishable both in morphology and staining reaction from their human equivalents with the usual staining methods (Jenner, Giemsa, Pappenheim, Harlow-Hayhurst, or Leischmann). As these stains are generally used in clinical haematology, and it seemed desirable to adhere as closely as possible to clinical methods for reasons stated above, my observations on the striking similarity between the white cells in human and in goats' blood refer to these staining methods only, though it is possible that there may be a slight cytologic difference which could be made visible by special methods. However, as the main object of this paper is to furnish data of comparison for those who wish to use goats in experimental work, cytologic details which may be of interest to hematologists, but do not play a prominent part in the clinical valuation of the blood picture, have not been taken into consideration. The striking similarity between normal leukocytes in man and the leukocytes in normal goat's blood is clearly demonstrated by the colored plates (Figs. 1-4).

AVERAGE NUMBER OF THE VARIOUS TYPES OF CELLS FOUND IN NORMAL GOATS.

Whereas a detailed account of the relative frequency with which the various types of cells occur in normal animals may be found in Tables III to X, the average percentage for each individual animal appears to be as follows:

¹³ Ellenberger, W., and Baum, H.: *Handbuch der vergleichenden Anatomie der Haustiere*. Berlin, Hirschwald, 1900. v. 2.

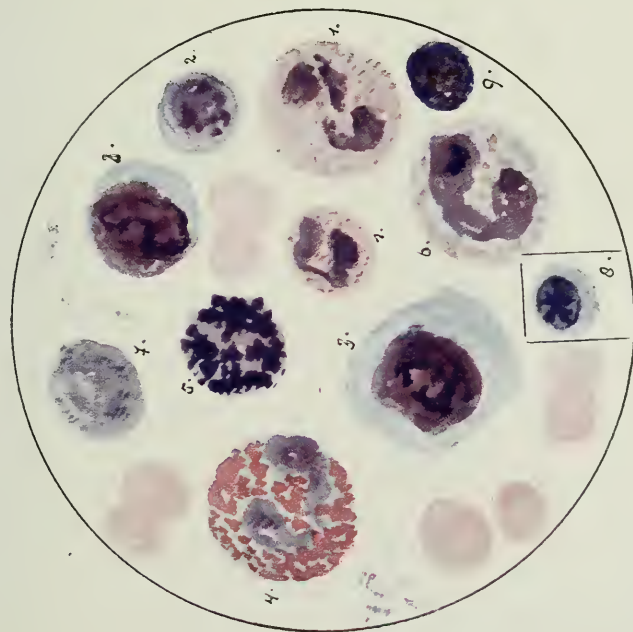
Goat No.	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Megaloblasts
WEEKLY COUNTS											
16	54.5	31.3	9.5	0.7	1.0	1.8	0.8	0	0.3	0	0
17	37.8	46.1	10.5	3.3	0.9	1.1	1.9	0.07	0.4	0	0
19	35.5	41.6	20.7	0.7	0.6	1.4	0.3	0	0	0	0
20	42.1	38.3	13.6	2.4	0.7	1.2	0.9	0	0.2	0	0
21	35.9	53.9	6.2	0.5	1.6	1.0	0.9	0	0	0	0
26	39.3	37.0	13.8	3.4	2.4	2.5	1.4	0.08	0	0	0
DAILY COUNTS											
35A	36.3	29.1	13.5	5.4	3.8	4.0	1.8	0.8	0.4	3.4	0.3
X	35.6	28.1	12.8	7.6	2.2	3.6	0.4	0.4	0.8	8.3	0.07
Total av.	39.6	38.7	12.6	3.0	1.7	2.1	1.1	0.2	0.3	1.5	.05

As shown by this summary the average percentage found in 51 differential counts for normal goats proved to be:

	Average 51 counts Per cent.	High limit Per cent.	Low limit Per cent.
Polymorphonuclear leukocytes	40.3	56.5	35.6
Small lymphocytes	35.6	53.0	28.5
Large lymphocytes	12.7	20.6	6.0
Eosinophile leukocytes	2.8	7.4	0.5
Mast-cells	1.6	3.7	0.6
Transitionals	2.0	4.0	0.8
Neutrophile myelocytes	0.9	2.1	0.2
Normoblasts	0.1	0.5	0.0
Türk's irritation cells	0.2	0.9	0.0
Atypical lymphocytes	1.3	8.0	0.0

CONDITIONS UNDER WHICH OBSERVATIONS WERE MADE.

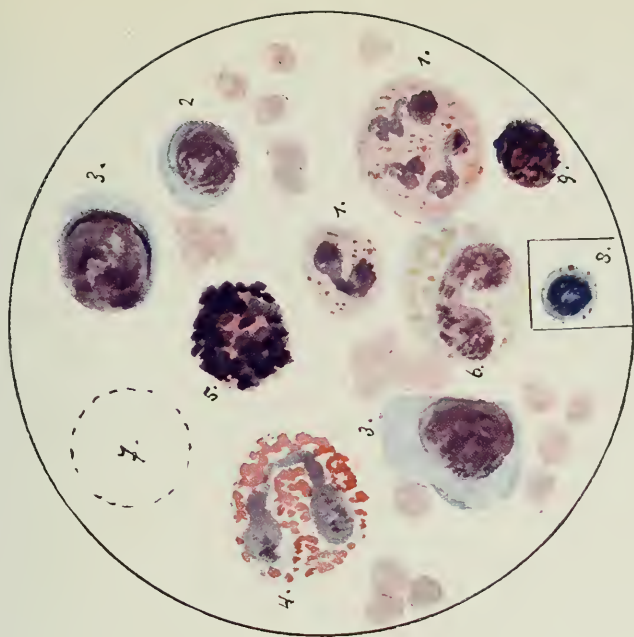
The goats used for these differential counts may be considered very fair representatives of the average laboratory animal. They were purchased in Texas where they had been on free range. The six animals used for the weekly counts had lived under



Normal Human Blood

Papanheim stain
Zeiss camera lucida

Normal Goat's Blood

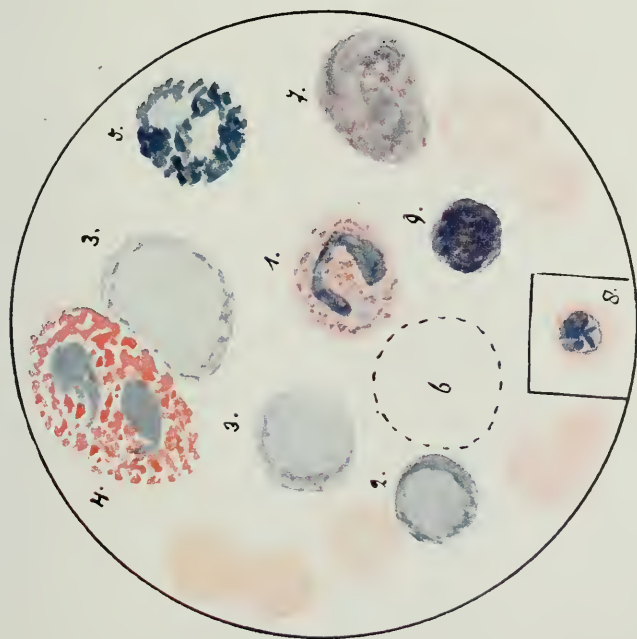


1. Polymorphonuclear leukocyte
2. Small lymphocyte
3. Large lymphocyte

4. Eosinophile leukocyte
5. Mast cell
6. Transitional

7. Neutrophile myelocyte
8. Normoblast
9. Atypical lymphocyte

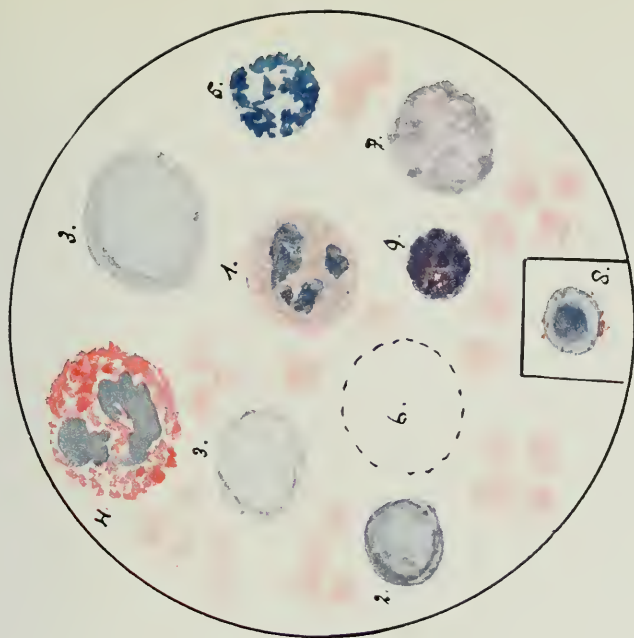
Figs. 1 and 2.



Normal Human Blood

{ Harlow-Hayhurst stain
Zeiss camera lucida x 700 }

Normal Goat's Blood



1. Polymorphonuclear leukocyte
2. Small lymphocyte
3. Large lymphocyte

4. Eosinophile leukocyte
5. Mast cell
6. Transitional*

7. Neutrophile myelocyte
8. Normoblast
9. Atypical lymphocyte

*The blank circle here indicates that no cell of corresponding type was found in eight slides of this blood examination.

Figs. 3 and 4.

laboratory conditions for two weeks when our counts were started. As neither the change of climate and food nor the lack of liberty and exercise appears to have influenced the blood picture to any considerable extent, the goats may be called "normal" as far as this term can be applied to any animal living in captivity, however favorable the conditions. For the weekly counts the common type of goat (*Capra hircus*) was used; of these animals one was a female, the others males. For the daily counts I used two typical Angora goats, one male and one female, that had lived under laboratory conditions for seven months. The age of our animals could not be determined with absolute accuracy, but is estimated at 5 months for the six common goats and approximately 12 months for the two Angoras, so that whereas the former must still be considered kids, the latter may be called young adult animals.

During the third week of counting, five of the six common goats developed slight symptoms of mange. The disease remained confined to small areas on the nose and ears, and cleared up in about two weeks on the application of a mixture of sulphur and vaseline. No changes were found in the blood picture during this period of extraneous parasitic infection, a fact recalling Washburn's statement that even intestinal parasites do not seem to alter the cytology of goat's blood, since various types of parasites are often found at necropsy in apparently normal animals. It will be remembered that in a number of cases the human blood picture has also remained unchanged although symptomatic evidence had corroborated the diagnosis of intestinal parasites.

The data furnished by my observations may be briefly summarized as follows:

1. Differential counts show that the blood picture in normal goats is subject to only slight variations.

2. The blood picture in kids or young adults**** does not seem to be materially influenced either by the breed or the sex of the animal.

3. Extraneous parasitic infection (mange) does not change the blood picture in any way, and various types of intestinal parasites do not appear to alter it to any considerable extent since at autopsy intestinal parasites are found in the greater number of apparently normal goats.

4. The stability of the blood picture seems to warrant the conclusion that goats are particularly well fitted for cytologic

**** Old goats will be made a subject of future study.

observations and that changes in the differential count caused by experimental conditions can hardly be considered accidental.

5. The similarity both in morphology and staining reaction between the leukocytes in the blood of man and in the blood of normal goats would seem to make it permissible to compare the changes occurring in the human blood pictures in disease and the pathologic changes observed in the blood of goats under experimental conditions.

TABLE I.

ERYTHROCYTES AND LEUKOCYTES IN THE BLOOD OF GOATS.

GOATS—(NATIVE SWISS SPECIES)

STORCH, A.

(Inaugural Dissertation, 1901, Bern).

No.	Sex	Erythro- cytes	Leuko- cytes	Propor- tion	Preg- nant	Erythro- cytes	Leuko- cytes	Propor- tion
5	M	15,300,000	11,520	1374				
8	F	13,839,000	12,594	1108	4	14,258,000	11,229	1272
8	K	10,151,000	11,358	827				

ANGORA GOATS.

WELLS, J. J., AND SUTTON, J. E.

(Am. J. of Physiol., 1915, xxxix, 31-36).

	Erythrocytes	Leukocytes
Suckling kid	11,748,000*	6,600
Milch	11,220,000	
Suckling kid	19,760,000	8,000
Milch	16,970,000	
Male, 76 days old....	19,376,000	12,250
Male, 69 days old....	22,344,000	12,500
Average adult	14,974,000	7,300
Average kid	20,864,000	12,525

ANGORAS—NORMAL.

MOHLER, J. R., AND WASHBURN, H. J.

(Bulletin 45, Bureau of Animal Industry, 1903).

No.	Erythrocytes	Leukocytes
9 Average	10,000,000	9,200

CAPRA HIRCUS.

MANN, F.

	Erythrocytes	Leukocytes
Male, 23 counts, Ave.	16,072,000	13,110
Female, 17 counts, Ave.	17,183,000	14,350

ANGORAS—NORMAL.

LUDEN, G.

	Erythrocytes	Leukocytes
Male (Goat X)	13,400,000	8,140
Female (Goat 35) . . .	18,800,000	11,200

CAPRA HIRCUS.

WARTHIN, A. S.

(J. of Med. Res., 1902, xii, 457).

	Erythrocytes	Leukocytes
Average	16,000,000	8,000

TABLE II.

ERYTHROCYTES, LEUKOCYTES AND HEMOGLOBIN IN THE BLOOD OF NORMAL GOATS (MANN).

GOAT 5—(MALE, CAPRA HIRCUS).

Date	Erythrocytes	Leukocytes	Hemoglobin
1915			Per cent.
7-29	17,125,000	13,000	Not given

GOAT 9—(FEMALE, CAPRA HIRCUS).

Date	Erythrocytes	Leukocytes	Hemoglobin
1915			Per cent.
7-29	16,700,000	9,800	..
8- 3	18,635,000	15,700	..
8-11	19,125,000	15,400	..
8-18	18,862,000	15,400	..
8-26	19,337,000	14,900	99
9- 1	19,275,000	13,800	97
9- 7	18,760,000	13,500	..
9-16	19,500,000	14,750	95
9-24	17,285,000	12,000	90
9-29	21,735,000	14,850	90
9-30	19,300,000	14,475	78
10- 1	20,475,000	14,000	80
10-12	16,550,000	14,300	70
10-20	16,850,000	13,000	..
10-27	18,350,000	18,450	..
11- 3	18,700,000	15,750	..
11- 8	20,800,000	12,000	..

GOAT 6—(MALE, CAPRA HIRCUS).

1915-1916	Per cent		
	Date	Erythrocytes	Leukocytes Hemoglobin
	7-29	20,000,000	13,100 ..
	7-30		
	8- 3	18,200,000	14,600 ..
	8-11	19,012,000	11,500 ..
	8-19	19,062,000	14,250 ..
	8-26	19,063,000	15,600 ..
	9- 5	19,237,000	13,000 98
	9- 8	19,250,000	15,200 ..
	9-22	23,975,000	11,650 85
	9-24	19,000,000	16,650 95
	9-28	19,700,000	13,300 85
	9-30	18,450,000	15,650 82
	10- 6	17,800,000	14,000 87
	10-14	21,050,000	13,950 90
	10-20	17,800,000	12,750 70
	11- 3	21,950,000	17,000 ..
	11-10	19,100,000	17,900 ..
	11-17	20,500,000	16,300 80
	11-23	23,050,000	15,150 ..
	12- 3	20,200,000	8,100 80
	12-10	20,000,000	15,850 75
	12-17	19,950,000	18,700 80
	12-22	19,950,000	12,000 80
	1- 3	24,350,000	11,550 90

TABLE III.
WEEKLY DIFFERENTIAL COUNTS—GOAT 16 (GROUP A)
Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
M	5	Common	Coarse white hair mixed with gray	13.4	9/16	56.0	21.0	13.5	0.0	1.5	6.0	2.0	0	0.0	0	0	0	
					10/18	56.5	36.0	6.0	0.5	0.0	1.0	0.0	0	0.0	0	0	0	0.17
					10/21	53.5	27.0	13.0	1.5	1.5	2.0	1.0	0	0.0	0	0	0	0.134
					10/25	54.5	35.5	5.5	0.5	1.0	1.5	0.5	0	1.0	0	0	0	0.112
					10/28	52.5	37.0	7.0	1.5	1.0	0.0	1.0	0	0.5	0	0	0	0.09
					11/ 8	54.0	31.0	12.0	0.0	1.0	0.5	0.0	0	0.5	0	0	0	0.112
					Average	54.5	31.3	9.5	0.7	1.0	1.8	0.8	0	0.3	0	0	0	0.103

TABLE IV.
WEEKLY DIFFERENTIAL COUNTS—GOAT 17 (GROUP A)
Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
F	4	Common	Coarse white and cream. Maltese type	14.5	9/16 10/13 10/18 10/21 10/25 10/28 11/ 8	43.5 24.5 42.0 42.5 43.5 33.5 35.0	34.5 61.0 51.5 50.5 44.0 40.5 41.0	14.0 22.0 4.5 2.0 6.0 9.5* 15.5	0.5 1.5 0.0 3.5 2.5 11.0 2.0	1.0 1.0 0.5 0.5 0.5 2.0 1.0	0.5 1.0 1.5 0.0 0.5 2.0 2.5	6.0 0.0 0.0 0 3.5 0.5 2.5	0 0 0 0 0 0 .5	0 0 0 0 0 1.0 1.0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	 0.119 0.112 0.07 0.13 0.13
Average						37.8	46.1	10.5	3.3	.9	1.1	1.9	.07	.4	0	0	0	0.801

* Two mitoses.

TABLE V.
WEEKLY DIFFERENTIAL COUNTS—GOAT 19 (GROUP A)
Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
M	5	Common	Coarse yellowish hair	12.7	10/13	18.0	42.0	39.0	1.5	0.0	2.5	1.0	0	0	0	0	0	0.17
					10/18	36.5	40.5	18.0	1.5	1.5	2.0	0.0	0	0	0	0	0	0.10
					10/21	33.5	49.0	17.0	0.0	0.0	0.0	0.5	0	0	0	0	0	0.094
					10/25	51.0	29.0	17.5	0.0	0.5	2.0	0.0	0	0	0	0	0	0.112
					10/28	38.5	47.5	12.0	0.5	1.0	0.5	0.0	0	0	0	0	0	0.168
Average						35.5	41.6	20.7	0.7	0.6	1.4	0.3	0	0	0	0	0	0.129

TABLE VI.
WEEKLY DIFFERENTIAL COUNTS—GOAT 20 (GROUP A)
Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
M	4	Common	Silky White hair	12.4	9/16	41.0	45.0	12.0	.5	.5	1.0	0.0	0	0.0	0.0	0	0	
					10/13	38.0	30.5	23.0	1.5	0.0	1.0	0.5	0	0.0	0.0	0	0	0.114
					10/18	27.5	56.0	14.5	0.0	0.5	1.0	0.0	0	1.0	1.0	0	0	0.096
					10/21	48.5	32.5	8.5	1.5	2.5	1.0	5.5	0	0.0	1.0	0	0	0.084
					10/25	46.5	35.5	17.0	0.5	0.0	0.5	0.0	0	0.0	0.0	0	0	0.112
					10/28	42.0	40.0	15.0	1.5	1.0	0.5	0.0	0	0.0	0.0	0	0	0.112
					11/ 8	51.0	28.5	5.0	11.0	0.5	3.5	0.0	0	0.5	0.0	0	0	0.134
Average						42.1	38.3	13.6	2.4	0.7	1.2	0.9	0	0.2	0.3	0	0	0.931

TABLE VII.
WEEKLY DIFFERENTIAL COUNTS—GOAT 21 (GROUP A)
Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
M	5	Common	Coarse white hair	13.1	9/16	24.0	70.5	1.5	0.0	1.5	0.0	2.0	0	0	0	0	0	
					10/ 4	38.0	50.0	7.5	0.0	1.0	2.0	1.5	0	0	0	0	0	0.124
					10/18	30.0	60.5	7.5	1.0	1.0	0.0	0.0	0	0	0	0	0	0.084
					10/21	31.0	58.5	9.5	0.0	0.0	0.0	1.0	0	0	0	0	0	0.078
					10/25	38.0	53.5	5.5	0.0	1.0	1.0	1.0	0	0	0	0	0	0.07
					10/28	54.5	30.5	5.5	2.0	5.0	3.0	0.0	0	0	0	0	0	0.072
Average						35.9	53.9	6.2	0.5	1.6	1.0	0.9	0	0	0	0	0	0.071

TABLE VIII.
WEEKLY DIFFERENTIAL COUNTS—GOAT 21 (GROUP A)

Results expressed in per cent.

Sex	Age, Months	Breed	Description	Weight, kg.	Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Cholesterolin
M	+	Common	Coarse white and black hair	10.6	10/13	36.0	31.0	20.5	5.0	0.5	1.5	5.5	0.0	0	0	0	0	0.146
					10/18	37.5	38.5	17.5	2.0	3.0	1.5	0.0	0.0	0	0	0	0	0.09
					10/21	34.5	47.5	7.5	5.5	0.5	2.0	2.5	0.0	0	0	0	0	0.09
					10/25	41.0	42.0	9.5	2.0	5.5	0.0	0.0	0.0	0	0	0	0	0.10
					10/28	46.0	40.0	7.5	2.0	2.0	2.0	0.0	0.0	0	0	0	0	0.10
					11/ 8	40.5	23.0	20.5	4.0	3.0	8.0	0.5	0.0	0	0	0	0	0.13
Average						39.3	37.0	13.8	3.4	2.4	2.5	1.4	0.08	0	0	0	0	0.109

TABLE IX.

DAILY DIFFERENTIAL COUNTS—GOAT X (GROUP B)

Results expressed in per cent.

Sex	Age, Months	Breed	Description	* Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Megaloblasts	Large mononuclears
M	12	Angora	Black and white	3/ 3	35.0	35.5	15.0	4.0	4.0	7.0	1.5	0.0	1.0	0.0	0	0	0.0	0.0
				3/ 4	33.0	25.5	8.0	12.5	3.0	6.5	0.0	0.0	1.5	10.0	0	0	0.0	0.0
				3/ 6	32.0	22.5	7.0	8.5	1.0	7.5	0.0	0.0	2.5	19.5	0	0	0.0	0.0
				3/ 7	35.0	33.0	14.5	8.5	4.0	2.5	1.5	1.0	0.0	1.5	0	0	0.0	0.0
				3/ 8	27.5	33.5	13.5	14.5	2.0	1.5	0.0	1.0	1.0	5.5	0	0	0.0	0.0
				3/ 9	26.0	30.0	12.0	11.0	2.5	6.0	0.5	0.0	2.5	9.0	0	0	0.5	0.0
				3/10	33.5	31.0	14.5	6.0	1.0	1.5	1.0	0.0	0.0	10.0	0	0	0.5	0.5
				3/13	56.0	28.5	5.0	2.0	2.0	3.5	0.0	0.0	0.5	2.5	0	0	0.0	0.0
				3/14	45.0	33.0	12.0	10.0	1.0	2.5	0.0	0.0	0.0	2.5	0	0	0.0	0.0
				3/15	35.0	40.5	12.0	4.0	3.0	1.0	0.0	0.0	1.0	3.5	0	0	0.0	0.0
				3/16	35.0	23.5	15.5	9.5	2.5	1.0	0.0	2.5	0.0	10.5	0	0	0.0	0.0
				3/17	36.5	13.5	15.0	6.0	2.0	3.0	0.0	0.0	1.0	22.5	0	0	0.0	0.0
				3/18	35.5	32.0	17.5	6.5	2.0	2.5	1.0	0.5	0.0	2.5	0	0	0.0	0.0
				3/20	34.0	21.0	18.0	3.5	1.0	4.5	0.5	0.5	0.5	16.0	0	0	0.0	0.0
				Average	35.6	28.1	12.8	7.6	2.2	3.6	0.4	0.4	0.8	8.3	0	0	0.07	0.04

* February 28, Hemoglobin 55 per cent; erythrocytes, 13,400,000; leukocytes, 8,140.

TABLE X.

DAILY DIFFERENTIAL COUNTS—GOAT 35 (GROUP B)

Results expressed in per cent.

Sex	Age, Months	Breed	Description	*Date of count, 1915	Polymorphonuclear leukocytes	Small lymphocytes	Large lymphocytes	Eosinophile leukocytes	Mast cells	Transitionals	Myelocytes	Normoblasts	Türk's irritation cells	Atypical lymphocytes	Tumor I.	Tumor II.	Megakaryoblasts	Large mononuclears
F	12	Angora	White	3/ 3	36.5	29.0	9.5	6.0	7.5	4.5	4.0	2.0	0.0	1.0	0	0	0.0	0.0
				3/ 4	41.0	24.5	14.0	7.5	6.0	3.0	4.0	0.0	0.0	0.0	0	0	0.0	0.0
				3/ 6	22.0	37.5	17.5	7.5	5.0	6.0	4.0	0.0	0.0	0.5	0	0	0.0	0.0
				3/ 7	28.0	25.5	17.0	9.0	6.0	2.0	4.0	1.5	0.0	2.5	0	0	4.0	0.0
				3/ 8	33.0	30.0	13.0	5.5	3.0	3.5	1.0	0.0	0.0	6.0	0	0	0.0	0.0
				3/ 9	38.0	26.0	11.5	5.5	1.5	3.5	0.0	0.0	0.5	13.5	0	0	0.0	0.0
				3/10	37.0	27.0	15.0	4.5	2.5	3.5	0.0	0.0	1.0	0.0	0	0	0.5	0.0
				3/13	37.5	33.0	13.0	7.0	2.0	4.0	2.5	1.0	0.0	0.0	0	0	0.0	0.0
				3/14	48.0	28.0	10.0	2.0	3.0	6.0	2.0	0.0	1.5	0.0	0	0	0.0	0.0
				3/15	40.5	25.0	17.5	3.0	4.0	7.5	0.0	2.0	0.0	0.5	0	0	0.0	0.0
				3/16	40.5	33.0	13.0	2.5	3.5	2.5	0.0	0.0	0.5	4.0	0	0	0.0	0.0
				3/17	35.5	45.0	14.0	6.0	2.5	2.5	0.5	2.5	0.0	1.0	0	0	0.0	0.0
				3/18	36.0	31.0	16.0	8.0	3.0	2.5	0.0	2.0	0.0	1.5	0	0	0.0	0.0
				3/20	35.0	23.0	7.5	1.5	4.0	5.5	2.5	0.0	1.5	17.5	0	0	0.0	2.0
Average				36.3	29.1	13.5	5.4	5.4	3.8	4.0	1.8	0.8	0.4	3.4	0	0	0.3	0.1

* February 28, Hemoglobin 70 per cent; erythrocytes, 18,800,000; leukocytes, 11,200.

TYPES OF LESION IN THE LIVER IN CHRONIC PASSIVE CONGESTION.*

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ABSTRACT.

The microscopic picture of the liver in chronic passive congestion is very varied. As the result of a study of 112 cases five types of lesions have been recognized:—

I. Capillary dilation with atrophy of the liver cells especially about the center of the lobule.

II. Central degeneration of the liver cells with or without capillary dilatation.

III. Marked fat accumulation in the cells about the central veins with mid-zonal hyperemia or necrosis.

IV. Central necrosis with hemorrhage, often very extensive involving sometimes three-fourths or more of lobule.

V. Collapse fibrosis or so-called cardiac cirrhosis.

The type of lesion present at autopsy is determined chiefly by the degree of circulatory disturbance and its duration. Long continued stasis of slight or moderate grade, as in arteriosclerosis or emphysema, leads to capillary dilatation with progressive atrophy of the liver cells (type I). Degenerative changes in the cells toward the center of the lobule (type II) are due either to stasis of more marked degree or to moderate congestion in conjunction with infection. Extreme stasis results in central necrosis with hemorrhage (type IV) which passes over into collapse fibrosis (type V) if death be long enough delayed. The latter type of lesion occasionally results also from an extreme degree of atrophy (type I). Central fat accumulation with hyperemia of the intermediate zone (type III) is commonly associated with chronic rheumatic endocarditis in young individuals.

The necrosis of the liver cells in chronic passive congestion is the result of stasis alone (as shown by careful study of the clinical histories and autopsy protocols of our cases), leading to asphyxia of the cells farthest removed from their arterial blood supply. Infection plays a minor role, if any, though it probably contributes to the production of degenerative changes in the liver cells (type II). Most extensive necrosis with hemorrhage is not infrequently seen in cases of extreme stasis unassociated with infection.

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8, 1916.

Active regeneration of liver tissue is not regularly observed in chronic passive congestion. It is conspicuously absent in those cases of hemorrhagic necrosis where the loss of liver tissue is greatest. It is seen most often in cases of circulatory disturbances of long standing.

Chronic passive congestion never leads to the development of cirrhosis of the usual portal, nodular type. Collapse fibrosis, present in 16 of our cases, is not a true cirrhosis but a condensation of the reticular fibres, which may be somewhat increased, around the hepatic veins. In only 2 out of 112 cases of chronic passive congestion was an active new growth of connective tissue observed. In these only certain portions of the liver were affected, chiefly a narrow superficial zone beneath the capsule, and there was involvement of the *central* part of the lobule only.

ON THE COMPOSITION OF ADIPOCERE.† *

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The tabulated results of the quantitative analysis are as follows:

Palmitic acid	67.52%
Stearic acid	3.3
Oleic acid	5.24
̄ Hydroxy Stearic acid	9.48
κ Hydroxy Stearic acid	6.32
Stearin and Palmitin	1.21
Olein	0.16
Unsaponified matter	0.87
Calcium Soaps	4.41
Protein	0.665
Ash	0.578
Humus and Undetermined	0.247

† These remarks form an abstract of a paper presented at the Boston meeting of the American Association of Biological Chemists, January, 1916, and published in its present Vol. III, No. 3, page 12. They are given here in connection with specimen exhibited of the pig adipocere to which this analysis refers. It is of especial interest as being the first complete chemical analysis made.

* Read at the Meeting of the American Section of the International Association of Medical Museums, Washington, D. C., May 8th, 1916.



FIG. 1. ANTERIOR OR "FACIAL" ASPECT.

FIG. 2. POSTERIOR VIEW.



FIG. 3. SKIAGRAM.



FIG. 4. Thoracic Organs. 1 and 1, smaller lungs; 2, smaller, one-chambered heart; 3 and 4, neck encircling arterial branches; 5, venous trunk from one-chambered heart to right auricle of main or larger heart; 6, cervical arterial branch (anomalous common carotid?); 7 and 7, larger lungs; 8, aorta dextra; 9, aorta sinistra; 10, defective interventricular wall; 11, left ventricle; 12, right ventricle.

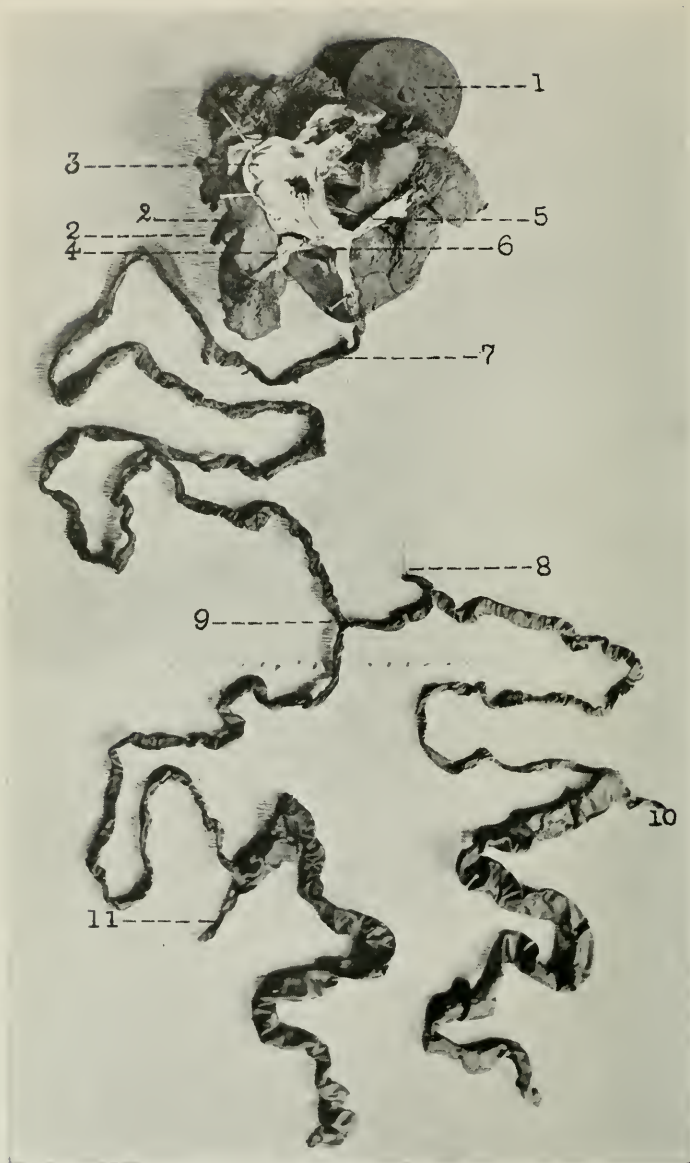


FIG. 5. 1, larger liver; 2, smaller liver; 3, stomach; 4, bile duct from gall-bladder of small liver; 5, bile duct from gall-bladder of larger liver; 6, duodenum; 7, single small intestine; 8, diverticulum; 9, point where duplication of intestine occurs; 10 and 11, appendices.

The fat acids and traces of fats, etc., soluble in ether constituted 94.1% of the adipocere and gave the following physical and chemical constants:

Sp. gr. at 100°C.....	.8436
Refract. Index at 60°.....	1.436
Melting point	60-63°C.
Acid value	201.7
Saponification value	207.0
Iodine value	6.04
Acetyl value	34.75

The total nitrogen present was only 0.1778%, of which only .0289% was ammonia nitrogen.

As a result of the studies recorded in this paper we are justified in concluding that adipocere is the residue of the pre-existing fats of animals. It is composed almost entirely of the insoluble fat acids left after the slow hydrolysis of the fats in wet ground. The protein matter has entirely disappeared and the glycerine soaps, etc., resulting from the hydrolysis carried away in aqueous solution.

The insoluble hydroxy stearic acids which are so characteristic of adipocere are derived from a portion of the oleic acid in the original fat by hydration. There is no evidence of this conversion of protein into fat acids in the formation of adipocere.

No margaric acid or oxy margaric acid is present. Ammonia and other soluble soaps are absent and only the calcium salts are present in small quantity in a matured specimen of adipocere such as that reported upon.

The specimen from which portions were taken for analysis is in the Pathological Museum of McGill University.

DOUBLE MONSTER OF JANUS TYPE:
CEPHALOTHORACOPAGUS MONOSYMMETROS
CYCLOPS SYNOTUS.*

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McGill University, Montreal.
(*From the Medical Museum.*)

In this interesting form of double monster we have an excellent example of very early dichotomy giving rise to two parallel primitive streaks which are developed side by side and in turn

* Read at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

giving rise to a monster the result of fusional duplication. In this case, therefore, it will be seen that a complete cleavage has occurred very early and a secondary fusion has been brought about between contiguous parts of the body, also at an early period. There are many possible varieties of this type of fusion, for example, head to head, waist to waist, in an axial direction, and so on. At times the directions of growth and interference of tissues with one another lead to the suppression of certain parts of the anatomy. The specimen here reported is perhaps the most interesting and the strangest of this group of monstrosities. As one looks at the monster one observes a broad head and face, two arms, and two legs, and if one walks around it an exactly similar appearance presents itself on the other side, but not of an equal development. In this case the fusion has been so unequal that the two facial surfaces are markedly different and it gives one the impression that the generous development of one side has taken place greatly at the expense of the other or diminutive side. Briefly, the resulting double foetus has a single broad head having two faces, one looking either way, and a single thoracico-abdominal cavity having two ventral aspects, corresponding to the two faces, while the backs, arms and lower portions of the bodies from the umbilicus down, remain independent units, becoming fully and symmetrically developed. Two forms of these so-called Janus monsters exists, according as the union has taken place in a straight line, that is at right angles to the vertical axis of the bodies of the respective foetuses, or obliquely as in this case, so that the fused faces on one side have not been able to develop fully. In the former case (symmetrical type) a Janus having two perfectly formed faces and symmetrical organs, will result. In the latter case, that in which the head ends have come together at an acute angle, one face will be perfectly formed, but the other will present the deformity above described, resulting from the inclusion and consequent non-development of the features along the median line (Janus monosymmetros). All degrees of facial asymmetry may exist from a simple narrowing of the space between the eyes and narrowing of the nose and mouth through a condition in which a single median eye (Cyclops) surmounted by a nasal proboscis, and ears united in the median line below a rudimentary chin (synotus), as in the example reported by us here, to a condition in which only a trace of the united ears below an apparently normal occiput remain as external evidence of the obliterated second face. As would naturally be supposed in these asymmetrical forms, the fused thoracic and abdominal viscera

share in the asymmetry, i. e., they are correspondingly smaller than the viscera of the perfect side. A glance at the accompanying diagram will explain on simple geometrical principles the development of these two types of Janus monsters.

The specimen here reported was presented to the Pathological Museum of McGill University by Dr. Andrew MacPhail. It is a very fine example of the monosymmetrical form of Janus, the face on the asymmetrical side showing the conditions of Cyclops and synotus referred to above. No clinical notes were obtained, except that the child was delivered at full term. The following is a careful description of the external appearance and the results of dissection of the specimen. Two photographs are appended, No. I showing the perfect, and, No. II the imperfect side of the monster. In referring to these surfaces in the description we will speak of them by these numbers I and II, and the foetus to the right and left of the perfect side will be spoken of as foetus A and foetus B respectively.

DESCRIPTION.

The body is that of two full term female foetuses united ventrally from the umbilicus upward so that face is fused with face, chest with chest, and upper part of abdomen with upper part of abdomen. The resulting double monster has a single broad head bearing two (compound) faces, one looking either way, and two occiputs placed laterally at right angles to the faces, a short broad neck surmounting a trunk which has a double ventral aspect corresponding to the two faces above, four arms, and two backs and spinal columns extending down below the occiputs. A single large umbilical cord is inserted into the fused abdomens, centrally, at their most dependent part. Below its insertion the two foetuses are entirely independent of each other, the lower half of the abdomens, the pelves with normal external genitalia, and the completely formed lower extremities of each foetus being seen placed laterally to the vertical axis of the composite trunk in a line with the spinal column of each, and at right angles to the double facial and ventral aspects. Thus in this monster the complete side, Figure I, is seen to be made up of the right half of the head, thorax, and upper abdomen with the right arm of foetus A, and of the left half of the head, thorax, and upper abdomen, with the left arm of foetus B, while vice versa the incomplete side, Figure II, is made up of the left arm, left half of the head, face, thorax and upper abdomen of foetus A, and the corresponding right parts of foetus B, the lower part of the abdomen, pelves and lower extremities of each remaining independent.

The bodies of both foetuses (A and B) are seen to be well developed, the fingers, toes, and nails of the eight extremities being perfect. There is a single thick composite neck (formed by fusion along the anterior surfaces) which has two backs, two sets of cervical spines forming part of the two perfectly developed spinal columns. The four shoulders are perfect but are pushed somewhat backward in each foetus by the approximation of the two thoraces in the ventral fusion, so that a deep groove remains between them on the dorsal aspect of each foetus. There is also a depression between the shoulders on the ventral aspects of the composite trunk which is most marked on the asymmetrical side, and which is apparently due to lack of space between the shoulder joints and the sternums.

The head is well covered with thick black hair. It is of a peculiar broad flattened shape, its widest diameter being laterally from occiput to occiput, where it measures 10.5 cm. From forehead to forehead it is 7.5 cm. The *symmetrical*, or perfect, side of the head has a broad face, which wears a mournful expression owing to the way in which the eyes and mouth are set, and bears traces on close examination of its double origin. The ears are large and well formed; they are wide apart (6.5 cm.), and are placed somewhat lower on the head than is normal, and in an oblique position, so that their upper ends look outward and their lower ends inwards towards each other. The chin is broad, the mouth small and depressed at either angle, the nose rather broad and flat with a well marked central depression at its cartilaginous tip. The eyes are rather small but they are otherwise normal and are provided with eyelashes. They are symmetrically placed on either side of the flattened bridge of the nose, in a somewhat slanting direction from within outward, so that each droops downward at the outer canthus towards the angle of the jaw, giving a curious expression. The forehead is high and rather broad, but the part free from hair tapers upwards to a central point. The eyebrows are well formed, but droop downward and outward as do the eyes.

The *incomplete* side presents a marked and characteristic deformity. It is much narrower than its fellow, and a single broad eye (Cyclops) covered by four rectangular lids, provided with eyelashes, occupies the centre of the face just below where the bridge of the nose should be. There is no sign of the nose as it is normally seen, but it is represented by a small snout-like protuberance over 1 cm. in length, which projects from the median line just above the single eye. This snout is channelled, and, when

PLATE I.
MODE OF DEVELOPMENT OF JANICEPS MONSTER.

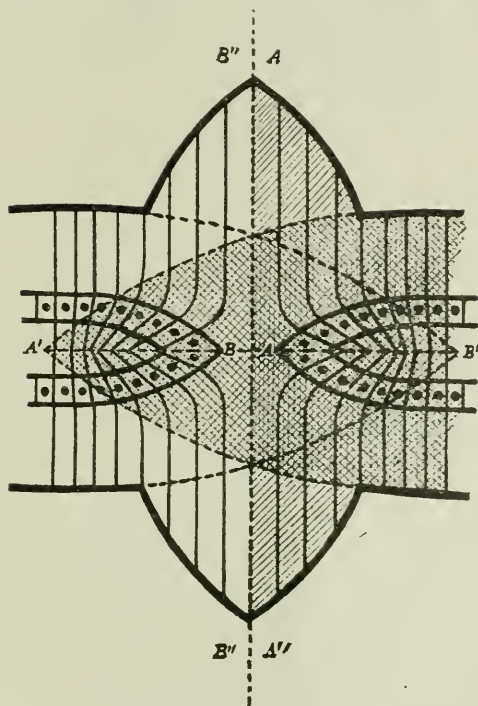


FIG. 1. DISYMMETRICAL JANICEPS MONSTER.

The longitudinal axes of the component embryos are in the same line. Fusion has taken place early in front of the growing points A and B respectively; as a result, instead of the cells of the head region derived from A growing to reach A', they are diverted by the opposing pressure of the cells derived from B; each face on either side is thus made up one-half from A (A'') the other from B (B'').

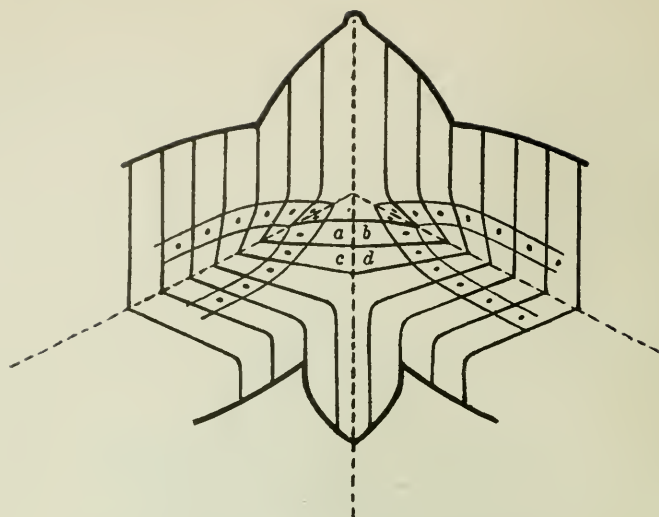
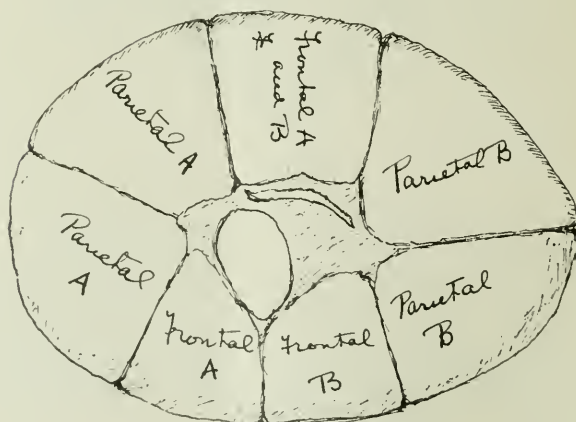


FIG. 2. ASYMMETRICAL JANICEPS MONSTER.

Apicopolar fusion at an angle less (or greater) than 180 degrees, with resultant failure to develop parts of the secondary face on the side of the lesser angle.

From General Pathology. J. G. Adami. Vol. I, p. 231.

II. INCOMPLETE SIDE.



I. COMPLETE SIDE.

FIG. 3.

Diagrammatic sketch of calvarium, showing two frontal bones on complete side (I), and single (fused) frontal on incomplete side (II). A and B refer to the foetus to which the various bones belong.

held up, resembles a small thick-walled tube. Two eyebrows slant obliquely downward on either side of the single eye. The forehead is narrow and lofty, reverse V-shaped in form, and covered, except in its central portion, with thick black hair. There is no mouth, but a curious small fleshy projection, .5 cm. in length, tapering to a flattened, red, and perforated apex, lies below the eye and suggests the superior maxillary process. Below this nodule the face recedes sharply, and in the depth of this receding angle lies a tiny rudimentary tongue. There is no chin, but the ears lie together in the middle line of the neck just beneath this small organ, occupying a horizontal position with their inferior parts touching each other (synotus).

On removal of the scalp the calvarium is exposed and presents the following appearances. It is smooth, oval from side to side, and has a centrally placed, large, diamond-shaped fontanelle, the widest diameter of which is from back to back (5 cm.) and its narrower (3.5 cm.) from face to face of the composite foetus. In it are two sesamoid bones, the larger of which measures 2×1.5 cm. On the complete side the calvarium is seen to consist of four bones, namely, one frontal and one parietal of each foetus. The two frontals are centrally placed, the right measuring 3×2.5 cm., and the left, which is slightly larger, 3×3.5 cm. These bones are definite and distinct from each other, and are held together by thick membranous tissue. The parietals on either side are trapezium-shaped, and each measures 5×5.5 cm. diagonally. On the incomplete side the calvarium occupies a smaller area than on the complete, being narrower from side to side. Here it is seen to consist of only three bones, a single large broad frontal, 3 cm. broad by 4 cm. long, which shows when held up to the light a central, thickened, bony deposit, representing the line of union of the two frontals from which it is formed. To the right and left of this fused frontal bone are two irregularly trapezoid bones measuring diagonally 5×6 cm. each, which represent the parietals of B and A respectively. The whole is shown in the accompanying sketch (Fig. 3). The cranium is closed in laterally and below on either side by the occipital bones of the two foetuses.

On removing the calvarium the inner aspect of the cranial cavity is seen. It presents a smooth, normally adherent dura, and is irregularly divided from side to side into two main divisions by a thick process of dura mater. The smaller division is on the incomplete side of the foetus. It measures 6.5 cm. at its widest part and about 4.5 cm. in altitude from the division as marked on the fontanelle to the base of the skull. The larger division is on the

complete side. Each division contains two cerebral hemispheres, those in the smaller division (incomplete side) being small, devoid of sulci or convolutions, and having a finely granular aspect, while the hemispheres in the larger division (complete side) are much larger, and show well-marked sulci and convolutions which, except for their irregular outline have the appearance of normal brain. The cerebral hemispheres on the incomplete side are less than one quarter the size of those on the complete side, and are imperfectly divided from each other by a single fissure. A similar fissure completely divides the hemispheres on the complete side. There is a well formed cerebellum for each foetus situated posteriorly (laterally in the specimen) above the neck of each. The olfactory nerves are absent on the incomplete side. With this exception the cranial nerves are all present and paired. The optic nerves running to the complete side are well apart, those on the incomplete side are placed well together, are smaller than their fellows, and run forwards to the single eye.

There is definitely a fusion of only the two forebrains, the mid and hind brains being perfect on each side. The peduncles, corpora mamillaria, optic thalami on the incomplete side are somewhat smaller than those on the complete, that is, the half of each cerebellum touching on the incomplete side is less developed than the half touching on the complete side. A peduncle runs from each cerebellum to the incomplete half and one from each to the complete half. There is apparently a fusion of the pituitary bodies on the incomplete side.

DISSECTION OF THE BODY.

Of the two sternums present that on the incomplete side is smaller and softer than the other, presenting irregular centres of ossification. Two perfectly developed hearts are placed ventrally one on the left side of either surface; that on the incomplete side being smaller in all respects than that on the complete. That each of these hearts was derived from the fusion of the right chambers of one foetus with the left chambers of the other, was proved by their relationship to the lungs. Each heart gives off a large branch to a large common aorta which descends vertically. There are four lungs present. The pair on the complete side are formed by the right lung of foetus A, and the left lung of foetus B, and they derive their blood supply from the larger heart which lies on the left aspect of this surface. The lungs of the incomplete side are formed by the right lung of A, and the left lung of B, and are connected with the smaller heart of their surface. There is a



PLATE II. THE SYMMETRICAL SIDE.

Cephalo-thoracopagus monosymmetros cyclops synotus. A double monster of the Janus type in which the heads of the foetuses, and their bodies as far as the umbilicus are fused along their ventral aspect, a single body having four arms and four legs, and a face looking to either side resulting.



PLATE III. THE ASYMMETRICAL SIDE.

Cephalothoracopagus monosymmetros cyclops synotus. On this side of the double foetus fusion has taken place at a somewhat acute angle, so that the two halves of the face (one of which has been derived from either foetus), have been reduced along the median line, a single eye (Cyclops), centrally placed, with the nasal proboscis displaced above it, and the ears approximated to each other beneath the chin. (Synotus, resulting.)

single trachea present and a large common oesophagus which runs down to the left of the incomplete side to reach a large balloon-shaped common stomach. There are two livers formed, and two gall bladders which open by separate ducts into a common duodenum. The diaphragm is perforated by two inferior cavae, one going to either heart. The intestines are common until the place of insertion of the omphalomesenteric duct. Here the small intestine widens and divides into the two parts in which it is continued. All the structures below this point, i. e., the remainder of the small intestine, the caecum, appendix, colon, rectum, as also the internal genitalia, are all of course double.

The following are briefly the most interesting points of the above report:—

I. We have here a typical example of early embryonic cleavage with secondary fusional duplication.

II. The line of fusion has been oblique resulting in an acute angular fusion on one side, and an obtuse angular fusion on the other.

III. The resulting monstrosity is a monosymmetrical Janiceps; where fusion was on the acute angle side we have the asymmetrical, or poorly developed, side of the monster, and where the fusion was on the obtuse angle side we have the symmetrical, or fully developed, side of the monster.

IV. The fusion was along the ventral aspects from head down to omphalomesenteric duct, consisting of fusion of heads, necks, thoraces, and upper half of the abdomen and their contents, while below the omphalomesenteric ducts all parts were normally developed and tends further to support the equality of the originally cleaved halves, and that the resulting monstrosity of the upper part of the body and head was due to a bad angular fusion.

REPORT ON A CASE OF CEPHALOTHORACOPAGUS MONOSYMMETROS.

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(*Published from the Wm. H. Singer Memorial Research
Laboratory.*)

Because of many interesting features and especially on account of the peculiar anomalies of the vascular system found in a monster occurring in the practice of Dr. Scheffer, it was thought to be of sufficient interest to merit a report.

CLINICAL HISTORY.

Mrs. L. F., the mother of the monster described in this paper, was a white woman, aged 31 years, and married. Her height was 5 feet 6 inches, weight 154 pounds, and occupation, housewife. Concerning her past history, her general health had been good. Menstruation began at the age of seventeen. She had had one previous instrumental delivery, the child being alive and normal at the present time. There had been one miscarriage.

Regarding the last pregnancy there had been no untoward clinical symptoms except the unusual degree of abdominal distension with consequent discomfort. Her pelvis was of the flat rhachitic type. A diagnosis of twins in the L. O. A. position was made on account of the double heart sounds and from the palpatory findings. Labor occurred spontaneously at term and began at four P. M. with a vertex presentation. It progressed normally until the shoulders reached the superior strait when advancement stopped. Delivery, twelve hours after onset of labor, was then effected under general anaesthesia by means of forceps.

The child emitted a few gurgling sounds and lived about five minutes after birth.

The puerperium was uneventful with the exception of the development of a thrombo-phlebitis of the left leg on the sixth day. The patient subsequently made good recovery.

It might be of interest to note that the wife of each of the patient's two brothers had borne twins.

PROTOCOL.

The monster exhibited the following features externally: There was ventral fusion of the two bodies as far as the common umbilicus. Below this point there were two female bodies, separate, normally formed, and in all respects symmetrical. The extreme length was 36 cm. The upper and lower extremities of each body were equally and normally developed. That ventral fusion had occurred at an angle of less than 180 degrees was indicated by the fact that the distance between the heads of the humeri on the anterior, or facial aspect was 9 cm., while that between the humeri of the lesser, or posterior aspect was only 6 cm. Moreover, there was only one face, the secondary or defective face being entirely absent, fusion having occurred posterior to the secondary ears, so commonly found in this type of monsters. The two occiputs were fairly distinct. The face was practically normal in appearance

with the exception of the mouth. Fusion of the mandibular processes had not occurred. The lower lip was cleft, and invaginated along either side of the protruding tongue to which it was attached.

HEAD.

The scalp was covered by short, fine blond hair. On incising the scalp and rolling it back, the bones and sutures presented the following arrangement. Anteriorly, the bones and sutures were normal, there being the usual unfused double frontal, two parietal and temporal bones, coronal and sagittal sutures. At the location of the posterior fontanel however, there was a large triangular shaped fontanel. Posteriorly this was bounded by a polygonal bone representing a common or fused parietal bone. Separating this bone on each side from the adjacent parietal bone was a suture which anteriorly joined each lateral angle of the large posterior fontanel. Postero-laterally each of these secondary sagittal sutures joined with their respective secondary lambdoidal sutures. These bounded the two occipital bones anteriorly and posteriorly and separated them on one side from the normally situated parietal bone, and on the other side from the small common parietal bone which lay between them. Inspection of the interior of the skull disclosed two distinct cerebellar fossae. The anterior and middle fossae were not duplicated.

BRAIN.

The cerebrum was normal in appearance. The optic chiasm was single. There were two sellae turcicae and two hypophyses. At the crura the single axis became double, and distinct, there being two pontes, two medullae, two cerebella and two spinal cords.

OROPHARYNGEAL CAVITY.

There was a large, common, oropharyngeal cavity. The "anterior" or projecting tongue seen in Figure I was attached anteriorly to the floor of the buccal cavity and to the cleft lower lip and posteriorly to the posterior wall of the pharynx. Two narrow bands of tissue arising from the postero-lateral surfaces of this tongue were also attached to the pharynx posteriorly. Beneath the posterior portion of the tongue was the opening into the main larynx. Just posterior to this was the single and common oesophageal opening in the floor of the oropharyngeal cavity. Still posterior to this opening was the lesser laryngeal cleft or orifice situated beneath the base of the lesser, or

"posterior" tongue with the cleft lying in the vertical instead of the horizontal plane. The "posterior" tongue was attached at its base to the posterior margin of the oropharyngeal floor with its base directed anteriorly toward the base of the "anterior" or visible tongue, and also latero-posteriorly to the pharyngeal wall in common with the other tongue. On account of this peculiar mode of attachment the "posterior" tongue was twisted or partially rotated on its long axis to one side, accommodating itself to a relatively small space and with the greater portion of its surface in close proximity to the pharyngeal wall. Finally, there was a relatively thick band of tissue extending from the base of the "posterior" tongue across the oesophageal opening to the anterior commissure of the "anterior" larynx.

THORAX.

The conditions found in the thorax were especially interesting. As may be understood after consulting Figs. I and II the upper ribs of the opposite sides of the two bodies were joined to a common rudimentary sternum, one for the anterior aspect and a still less developed one for the posterior aspect. There was duplication of the viscera. The noteworthy feature was the structure and relationship of the two hearts and the arrangement of the larger vessels. The smaller heart consisted of one main chamber. Opening into this were two pulmonary veins from the two smaller lungs, and also the inferior vena cava of this side. A relatively large vein connected it with the right auricle of the other or larger heart. This vessel, (Fig. 4), received one or more tributaries from the cervical region and evidently corresponded to an anomalous vena cava superior. There were two small, apparently obliterated (? arterial) vessels arising from the superior pole of the one-chambered heart. These passed upward closely parallel to each other for a short distance and connected with the larger aortic branches (3 and 4, Fig. 4).

The main or larger heart was hypertrophied. It exhibited the following interesting anomalies. The auricles were divided by a thin, imperfect, membranous septum in which there was a very large foramen ovale. The auricle which evidently represented the left auricular chamber received two vessels, one from each of the two larger lungs, evidently the pulmonary veins. The other, or right auricle received the inferior vena cava of this side. The venous trunk (5, Fig. IV) bringing blood from the lesser, one-chambered heart and cervical region, also opened into this auricle just lateral to the large foramen ovale. A set of valves

guarded the opening from the right auricle into the right ventricle. The right ventricle gave origin to no arterial trunk, but communicated with the left ventricle by a large, half-moon shaped opening situated just below the auricular floor in the septum ventriculorum. The left ventricle and the left auricle were separated by a set of valves. The left ventricle gave off two aortae which supplied the two fused bodies. These vessels while arising in close proximity to each other were entirely separate and distinct, their respective origins being about 3 mm. apart. For the sake of clearness these vessels will be called aorta dextra and aorta sinistra relative to the positions in which they occurred with regard to the facial or anterior aspect of the monster. From the first portion of the ascending arch of aorta sinistra two distinct vessels of fairly large calibre were given off and evidently represented two pulmonary arteries as each passed backward and laterally to its corresponding lung. From the base of the ascending arch of aorta dextra a relatively large vessel passed upward and laterally to the cervical region and apparently corresponded to the left common carotid. About 2 cm. from its origin it was joined by a branch from the transverse arch of aorta sinistra, the two fusing to form one vessel which passed headward. At about the place where the transverse arch turned downward to form the descending arch a large trunk (3 and 4, Fig. IV), was given off from each aorta and passed backward, one on each side of the neck, encircling the cervical region like a collar and terminating in the lesser lungs of the opposite side. (Fig. IV). Two small branches connected with the rudimentary ascending (? arterial) trunks of the one-chambered heart.

Also, arising from these long, neck encircling trunks were cervical branches. Owing to the fact that the organs had to be removed *en masse* through a low, transverse, abdominal incision, the subclavian vessels could not be definitely identified. It appears probable, however, that one subclavian artery on each side, the ones nearest the "facial aspect" of the monster, arose from its corresponding aorta, while the other two subclavians arose from their respective long neck encircling trunks (3 and 4). Continuing downward the two aortae supplied the abdominal viscera and lower extremities of their respective bodies. In brief recapitulation then, the vascular system presented the following chief features. The one-chambered, or lesser heart apparently acted as a subsidiary pump to propel venous blood brought from the abdominal viscera and lower extremities and probably in part, from the head region of its respective body over into the right auricle of the

chief heart. This latter organ through the two aortae sent blood to both bodies. Finally, it is apparent that there must have been a free intermingling of venous and arterial blood.

ABDOMINAL CAVITY.

The upper part of the abdomen formed a single common cavity with respect to the two bodies. At the level of the umbilicus the bodies became separate each with a distinct abdominal cavity normally formed. The diaphragm was imperfect, there being a large opening on the side of the left body viewed from the anterior aspect. There was, however, no hernia of thoracic or abdominal organs through this opening.

LIVERS.

The larger or main liver was situated with its antero-superior surface toward the abdominal wall of the facial aspect. It was considerably larger than the smaller liver which lay directly posterior with the stomach between them. Each liver had its respective gall-bladder.

GASTRO-INTESTINAL TRACT.

The stomach was single and lay between the lesser and main liver. The duodenum received a bile-duct from each gall-bladder. The upper, or jejunal portion of the small intestine was single, the only suggestion of any duplication being a delicate fibrous cord which was apparently attached to the mesentery in the region of the duodenum. The remainder of the intestine including ileum and colon was duplicated. Each colon contained meconium.

GENITO-URINARY SYSTEMS.

The kidneys were duplicated, situated in their usual positions, and were of the ordinary, lobulated, foetal type. The ureters were normal and opened into their respective bladders, both of which had a patulous urethra. The internal and external genitalia were of normal female type in both bodies.

In conclusion the scope of this paper will not permit a discussion of the various theories attempting to explain the formation of such a monster as has just been described. It may not be amiss, however, to briefly state that the nature of the duplication in this case appears to be explained best according to Adami who believes that there has been derivation from a common germinal area with more or less complete dichotomy before the end of the gastrula stage and later apicopolar fusion before the

head curve has developed, with consequent approximation of the superior growing points in the region of the infundibula. To quote directly from Adami's text—Vol. 1—Page 250: "when the main axis of the two embryos are not in a straight line, then on the side in which the angle of juncture is less than 180 degrees a certain number of cells of the same embryo destined to develop parts of the face by growth in a latero-superior direction will, in their growth forward, find themselves opposed and arrested by the equal force with which the corresponding cells of the other embryo are tending to grow in an exactly opposite direction. When forces, equal and opposite, meet each other,—the result is that they neutralize each other; in other words, portions of the facial parts do not develop."

In this case then fusion was at such an angle that the secondary defective face practically did not develop. This monster would consequently be designated a cephalothoracopagus monosymmetros.

For numerous valuable suggestions and the photographs we desire to express our appreciation to Dr. S. R. Haythorn.

FOETUS HOLOACARDIUS ACORMUS IN HETEROLOGOUS (TRIPLET) PREGNANCY.*

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(From the Medical Museum of McGill University.)

(Preliminary Report).

The term *acardiac monster* is applied to those cases of uniovular double or triple birth in which the motor force of the circulation of one foetus overpowers that in the other, so that the second becomes what may be termed a placental parasite upon the first. In such cases the heart of the parasitic twin becomes in whole or in part obliterated (*holoacardius*; *hemiacardius*), and its blood supply is propelled through its cord by the action of the heart of its fellow. The result is an ill-formed mass, more or less

* Presented at the Meeting of the American Section, International Association of Medical Museums, Washington, D. C., May 8th, 1916.

differentiated into trunk, caudal and cephalic ends, and rudimentary extremities.

The development of the head end very rarely predominates. According to Schwalbe, only four well authenticated cases are recorded. To such cases of predominant development of the cephalic end, with or without rudimentary trunk remains, the term *foetus holoacardius acornus* is given. The present communication is a very brief preliminary report of a fifth case of this rare type of monstrosity, in which it is to be noted as a further point of interest that the acornus constituted one member of a heterologous triplet pregnancy. The specimen is illustrated in the accompanying plates (Figs. I and II) with its placenta, from which the cord of its uniovular fellow is seen emerging. A detailed study of this extremely rare and interesting case with full dissections and results of microscopic investigation will be published, by Dr. Phelan elsewhere, at a later date.

CLINICAL HISTORY.

The mother was a Canadian aged 21, single, nulliparous. Has had scarlet fever, personal history otherwise negative. Last period October 19th, 1911. Foetal movements first felt in February, 1912.

First seen on May 16th, 1912, in labor. The abdomen was markedly distended, and a diagnosis of twins in positions L. O. A. and L. S. A., with possible hydramnios was made. The pelvis was normal, temperature, pulse, and respiration also normal.

The pains began at 8 a. m., the first child was born at 2:40 p. m., the second at 2:50 p. m., and the third (the acardiac monster) at 3:00 p. m. The delivery was not complicated. The second child, distinctly larger than the first, was a breech presentation and was extracted without difficulty. After its delivery the fundus was felt to be still very large, and a large mass was palpable, which proved to be the third (acardiac) foetus. It was in a separate amnion which was included within the sac of the first child; and it received its blood supply by a small branch vessel arising from one of the large veins coursing over the placenta, which entered into formation of the cord of the first child. The placenta and membranes were intact.

Careful examination of the placental mass showed that it consisted of two placentae fused along their placental edge about 7 cm., and forming what at first sight appeared to be a single large placenta. There were two chorions and three distinct amnions. The amnion and chorion from those of the first, this

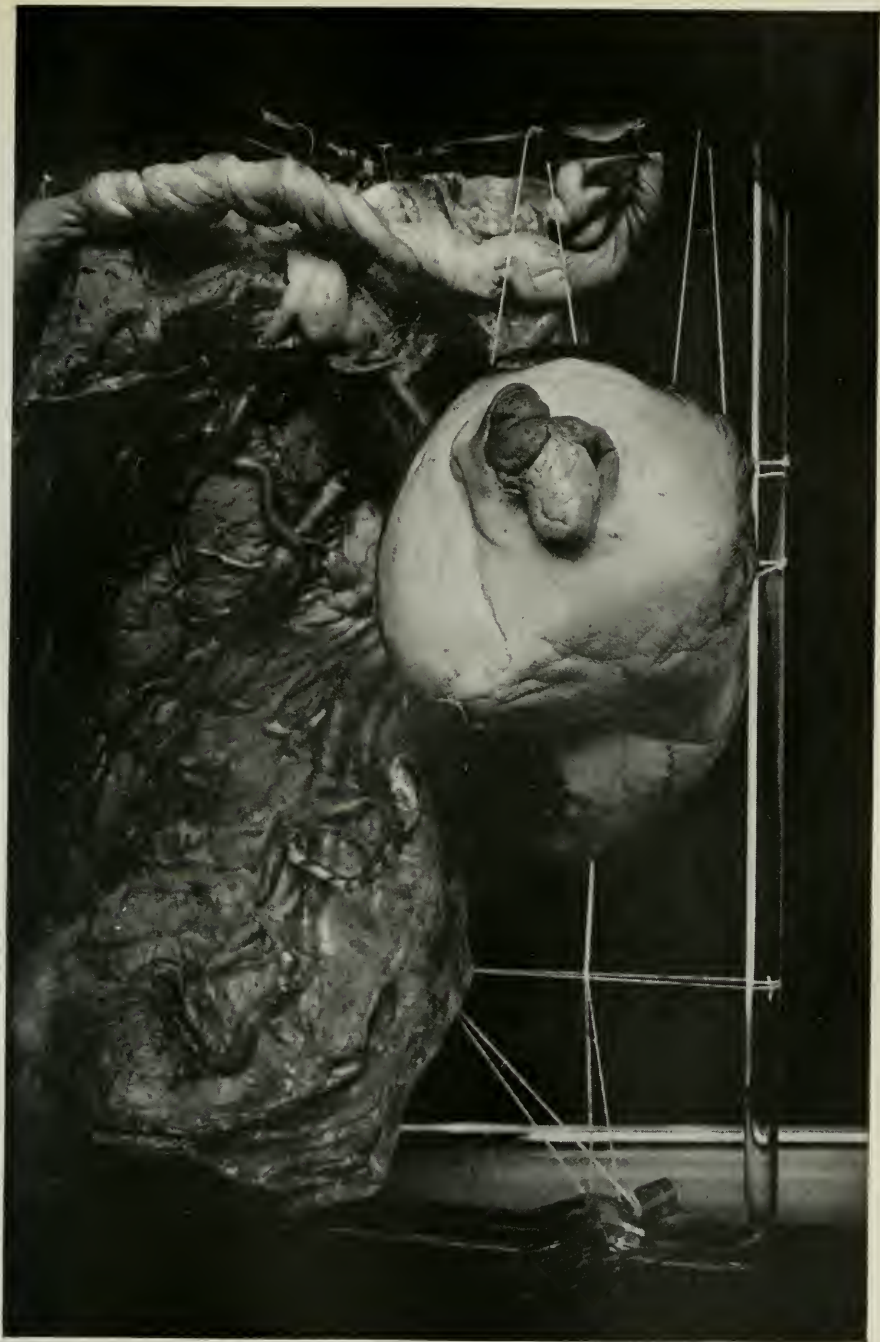


FIG. 1. Anterior view of acornus with foetal surface of placenta showing attachment of its cord to a large vein. Lip ring is plainly shown and the protruding tongue, also the sac-like structure attached to this posterior surface. From Specimen 5920, Medical Museum, McGill University, presented by Dr. G. W. Phelan.

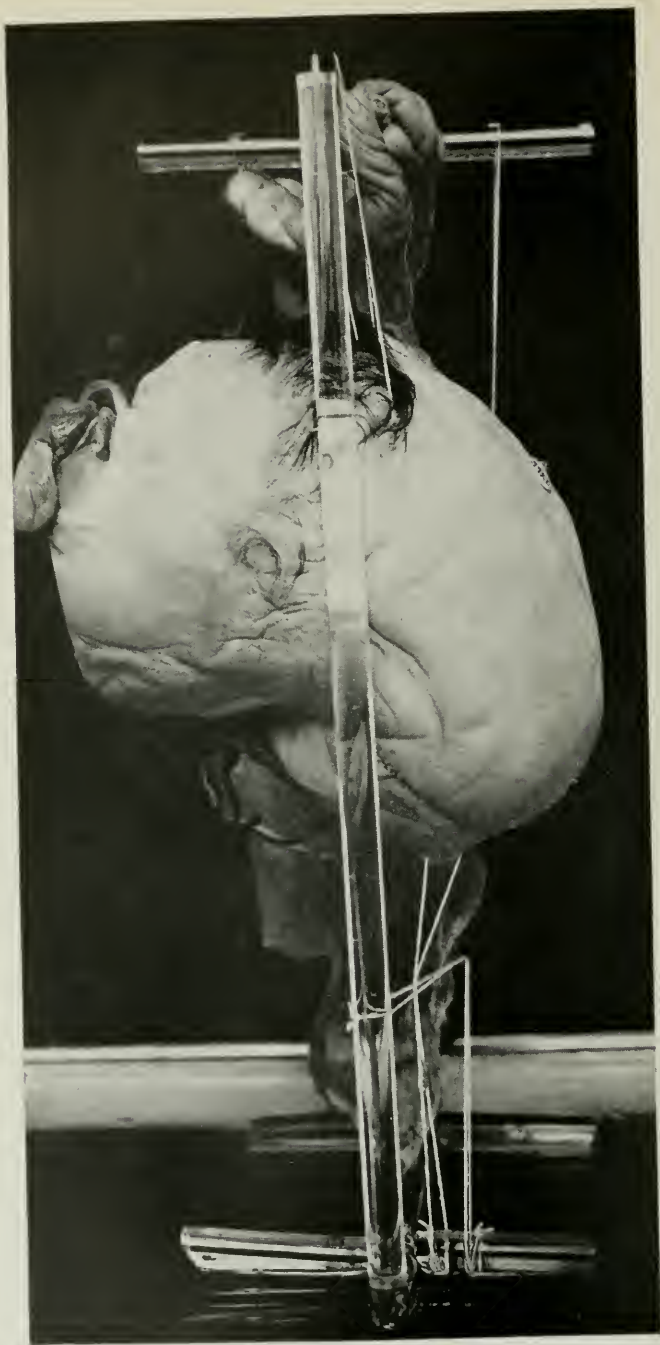


FIG. 2. Lateral view of acornus showing cowl of hair, protruding tongue, and cleft in lip ring. A portion of the gum is also plainly seen between the lip ring and the tongue.



FIG. 3. Skiagraph of acornus showing whorl-like arrangement of teeth, suspected temporal bone and undifferentiated cranial or skeletal mass posteriorly.

From skiagraph taken by Dr. A. H. Pirie, Royal Victoria Hospital.

foetus and the placenta to which it was attached are not shown in the illustration. This amniotic sac contained a great amount of fluid. The fact that the third foetus (the monster) received its nourishment from the blood supply of the first through its own very short rudimentary cord, probably explains why the first child was much smaller than the second, the conclusion being that the first and third foetuses were derived from a single ovum, while the second foetus was derived from a second ovum, the whole constituting a heterologous triplet pregnancy.

The patient became mentally deranged after the delivery, but her mental condition cleared up before her discharge on May 26th, 1912.

Details of the *three foetuses* may be thus summarized:

1. *First born.* A small but vigorous male child, weighing 1470 gms., 40 cm. in length, vertex presentation, which lived nine days, dying on May 25th.
2. *Second child.* Normal well-formed male child, larger than the first, weighing 1780 gms., 43 cm. in length, breech presentation. Still born. Excessive amount of liquor amnii.
3. *Third born.* Foetus holoacardius acornus. A mis-shapen mass, 19 cm. in length, consisting chiefly of the head end.

DESCRIPTION OF SPECIMEN.

The placenta, common to the acardiac monster, and the first child, has been preserved.

The *placenta* presents the picture of a full term placenta, discoid in shape, from which two cords arise. One of these cords is of large size and of quite normal character save that it possesses a velamentous insertion. To it the normal first born child, was attached. The second cord is very small, two inches in length, and consists only of a single small artery of microscopic size and one large dilated vein; it apparently springs from the largest vein of the placenta about 12 cm. from the point where this vein becomes a part of the cord of the first child. On the edge of the placenta opposite to the insertion of this minute cord are seen, upon the uterine surface of the chorion, the remains of the attachment of the second placenta which belonged to the heterologous member of the triplet pregnancy, and which has not been saved.

The acornic monster is a grotesque ovoid object resembling in size and shape an enormous magnified Lima bean, measuring in the hardened museum specimen approximately 12 x 8 x 8 cm. On its cephalic pole a large greatly distorted mouth can be made

out, protruding from which is an irregular tongue mass, to the lower edge of which is seen attached a loose sac the size of a large thumb-nail. The buccal cavity is bounded by a sharp angular ring of cartilaginous hardness covered with mucous membrane which represents gums, and which contains large teeth, as revealed by the X-ray and by palpation; this ring is again surrounded by a soft everted circular lip which is covered with epidermis without and by mucous membrane on its buccal side. Both these rings are continuous save at one point on their upper borders where they are sharply cleft resembling in appearance a hare lip, (although other signs of differentiation into the superior or inferior maxillae are not visible even in the X-ray). A distinct resemblance to a face is given by a cowl-like semicircle of reddish brown, slightly curly hair, which surrounds the upper half of the pole at a distance of about 4 cm. from the borders of the buccal cavity. The intervening skin is marked by a linear and a small circular deficiency in the epidermis so spaced as to resemble traces of eye clefts.

The remainder of the monster is covered by apparently normal epidermis.

The miniature cord enters the monstrosity about midway between its poles on its lower surface being received into a deep depression corresponding to the hilus of the bean to which it has been likened. Hanging from the cord at its entrance to the monster can be seen the remains of the torn amnion.

DESCRIPTION OF SKIAGRAPH.

The X-ray plate was kindly made by Dr. A. H. Pirie, who is now in charge of the X-Ray Department of the McGill General Hospital in France. For the following reading of the plate and for the remarkable photograph of it shown in Figure III, we are indebted to Dr. H. H. Cheney, Assistant Röntgenologist to the Royal Victoria Hospital:—

"The skiagraph was taken laterally and singly. In the anterior portion of the mass was found a whorl of incisor teeth, seven in number, attached to a membranous base smaller than the total mass of teeth. Behind this and intimately joined to it is another mass of equal length but slightly smaller in calibre which has the appearance of a temporal bone with the mastoid process included. Behind this is an amorphous mass about two-thirds the length of the parts referred to above. Form cannot be given to this with a single skiagraph but it rather suggests a spiral forma-

tion. The dark area in the accompanying photograph in my opinion is not calcareous to any extent but rather membranous and calcification is at its very earliest stage."

The writers' thanks are also due to Mr. H. H. Wootton, of the Royal Victoria Hospital, for the taking of the photographs.

REVERSED TORSION OF THE VENTRICULAR BEND
OF THE EMBRYONIC HEART IN THE EXPLAN-
ATION OF CERTAIN FORMS OF CARDIAC
ANOMALY.*

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(Presented by Dr. Abbott).

PRELIMINARY COMMUNICATION.

In the now quite well recognized anomaly known as transposition of the arterial trunks the aorta and pulmonary artery arise in more or less completely reversed relations; the aorta comes off anteriorly from the right ventricle and the pulmonary posteriorly from the left, the ventricles and auricles remaining as in the normal heart, that is, not sharing in the transposition. Such a state of things means of course a short circuiting of the circulation so that aerated blood is returned from the left ventricle to the lungs while venous blood is sent from the right ventricle back into the systemic circulation without aeration. It is naturally incompatible with life unless relieved by some compensating communication between the two circulations, such as is supplied by a patent ductus or foramen, or a defective inter-ventricular septum; even in these cases the condition leads at birth to the most extreme type of *morbus coeruleus* known.

The subject of transposition of the arterial trunks received its first elucidation from the great work of Rokitsanski, who in his elaborate monograph on cardiac defects attributes it to a deviation of the spirally placed aortic septum. Developing in the primitive common arterial trunk at an early stage, the septum normally divides it into an anteriorly placed pulmonary artery, which is thrown into exclusive communication with the right ventricle by the union of the aortic and interventricular septa, and a posterior-

* Presented before the American Association of Pathologists, and Exhibited at the American Section of the Museums Association, May, 1916.

ly placed aorta, which is united with the left ventricle in the same manner. In the light of the more exact knowledge of today this theory does not seem to meet all the facts, although it probably has a place in their explanation. The subject has been further studied by Dr. Arthur Keith and Dr. Jane Robertson¹, but the origin of this anomaly is still obscure.

During the course of a study of the recorded cases of congenital cardiac diseases made by one of us (M. E. A.) for a special purpose², our attention was attracted to a rare form of cardiac anomaly observed in a specimen in the Warren Anatomical Museum of the Harvard Medical School. In this specimen, as in six similar cases recorded in the literature (Young³, Peacock⁴, Rokitanski⁵ (two cases), Theremin, obs. 43, and Marchand⁶), the great vessels arise in transposed relations, and a malposed muscular septum cuts off a small chamber which gives off the aorta and is situated at the upper and anterior aspect of the ventricular portion of the heart. The large remaining portion of the ventricle gives off a small thin-walled pulmonary artery, receives the mitral and tricuspid orifices, and communicates with the small chamber by a large diamond shaped opening. This heart is from a youth of twenty-one, who died in 1838 of pulmonary phthisis. The most striking thing in its appearance is the transposition of the great trunks; the large thick walled ventrally placed aorta emerges anteriorly from the small imperfectly divided-off portion of the ventricle, and crosses in front of the pulmonary artery, which arises behind, in the position of the normal aorta, from the main portion of the large common ventricle. The distal relations of the two trunks to the aortic arch, including the right and left pulmonary branches and ductus arteriosus were apparently normal, and the atria and atrio-ventricular orifices are normally arranged. That is to say a true transposition of the arterial trunks, without transposition of the heart as a whole, exists. In Fig. 1 this heart is shown at B beside a normal one for comparison (A). (Fig. 1, B).

A specimen in the Museum of McGill University represents an interesting variant of the above anomaly, in that the great

¹ Journ. Path. and Bact. 1913, xviii, p. 191.

² Abbott, Osler and McCrae's System of Medicine, 2nd Edition, Vol. IV, 1915.

³ Journ. Anat. and Physiol., 1907, xli, 190.

⁴ Trans. Path. Soc., London, 1854, vi, 177.

⁵ Vienna, 1875.

⁶ Verh. d. XII Deut. path. Gesell, 1908, p. 17.

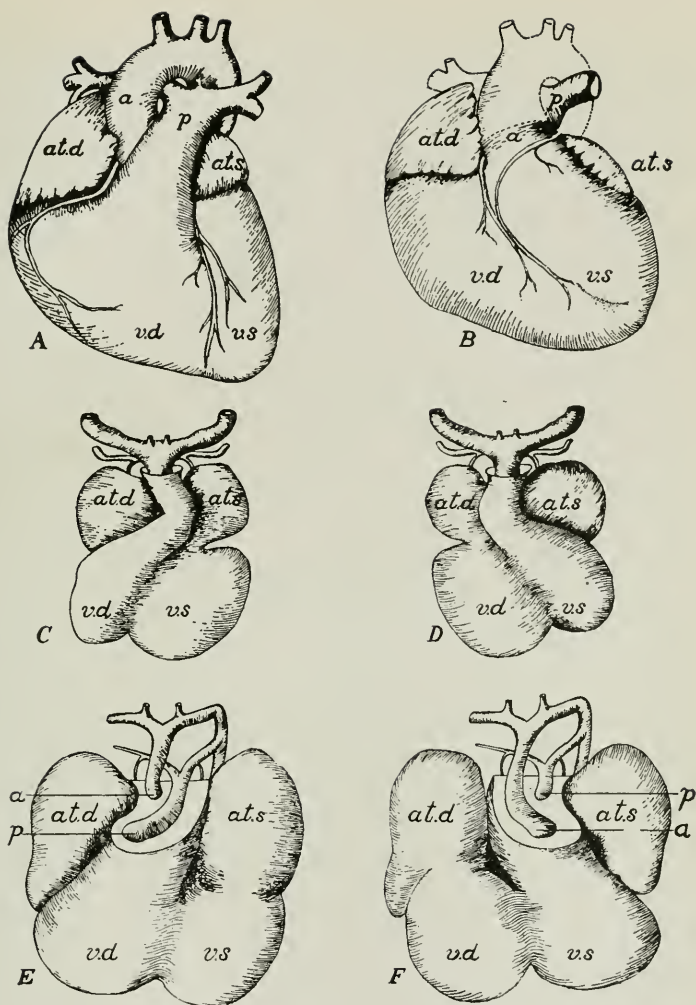


FIG. 1.

A, ventral view of a normal adult human heart. *B*, corresponding view of an adult human heart showing reversed torsion. *C*, model of the heart of a 4.9 human embryo, which in *D* has been manipulated so as to present reversed torsion. *E*, model of the normal heart of a 10 mm. human embryo, the torsion of which has been reversed in *F*.

a, aorta. *at. d*, right atrium (or auricle). *at. s*, left atrium (or auricle). *p*, pulmonary artery. *v. d*, right ventricle. *v. s*, left ventricle.

Reprinted from the Anatomical Record. Lewis and Abbott, 1915. Vol. 9.

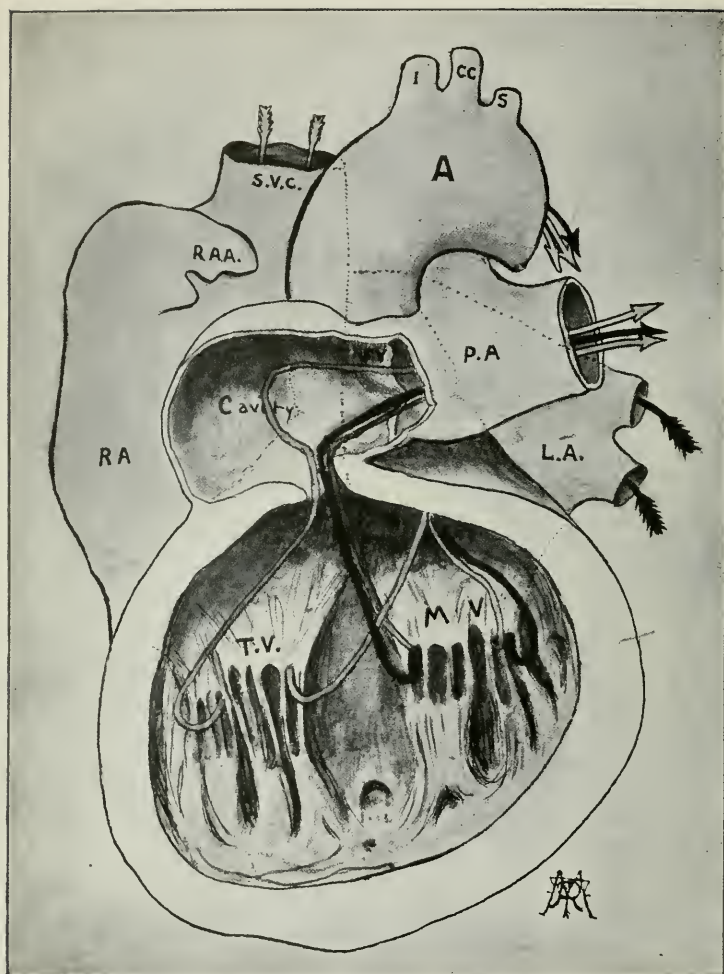


FIG. 2. Cor Biatrimum Triloculare with malposed interventricular septum, cutting off a small chamber which gives off the pulmonary artery from a large common ventricle which gives off the aorta.

Note that the great vessels are here in their normal relations, i. e., are not transposed. The pale line shows venous, the dark line arterial blood.

Diagrammatic sketch by Prof. R. Tait Mackenzie, from a specimen in the Medical Museum of McGill University, presented by Dr. Andrew Holmes, first Dean of the faculty in 1824.

trunks arise from the respective chambers in their normal instead of the transposed relations, thus proving that their transposition is not an essential part of the complicated anomaly presented by the Harvard heart and the like cases. This specimen, which in this particular is unique in the literature, was reported by the late Dr. Andrew Holmes⁷, first Dean of the Medical Faculty, in 1823. It is figured diagrammatically in Fig. 2.

The Harvard specimen was brought to Dr. Frederic Lewis by the writer for embryological interpretation and formed the starting point of the present investigation. From the conditions seen in the Holmes heart it was clearly evident that the problem to be explained was a two-fold one, namely, (a) the peculiar form of trilobulate heart common to all the cases in the series, and (b) the transposition of the great trunks complicating the present case. Dr. Lewis thought that the first of these two conditions probably represented an arrest of development at a stage shown in a model already made by himself of the interior of a 10 mm. embryo heart (Fig. I E.) and further suggested as an explanation of the transposition that in the embryo the cardiac tube had bent in the reverse direction to that which is normal, so that the aortic limb turned upward on the left side of the common ventricle instead of on the right, thus bringing the great vessels into an apparently reversed relation with the vessels of the arch. That such a reversed torsion of the cardiac tube can and does occur in life is shown in a plate in Remak's⁸ atlas in which the heart of a chick embryo at a very early stage before pouching of the auricles has occurred, is seen abnormally bent to the left side, while a second heart at the same stage, with the normal bending of the tube to the right, is shown in the same plate for comparison.

In order to verify Dr. Lewis' suggestion of reversed torsion as an explanation of transposition, (which we found had already been made by Keith), he and the writer together undertook the following investigation. Normal embryonic hearts at the critical stages were selected and modeled as they occur in the embryo. From the same set of drawings second models were then made in which the ventricular portion of the heart was reversed, section by section. The two models of the heart of a 4.9 mm. embryo, kindly loaned to us by Dr. A. S. Beggs, as also models of the ex-

⁷ Edin. Med. Chir. Soc., 1824, republished by M. E. Abbott, Montreal Med. Jour., 1901.

⁸ Remak, Untersuchungen über die Entw. der Wirbelthiere. Taf. iii, Figs. 28 and 29.

terior view of the heart of the 10 mm. human embryo have been completed in this way and are figured here (Fig. I, C-F). With others of the interior, which are still unfinished, they seem to demonstrate the correctness of the interpretation. The distal part of the aortic trunk, including the roots of the pulmonary and fourth aortic arches, remains undisturbed in all its relations, and the atria and atrio-ventricular orifices are also in essentially normal position. But the reversal of the primary torsion causes the aorta to be split off from the truncus arteriosus ventral to the pulmonary artery, around the front of which it swings to the left ventricle.

The interior view of the reversed model (Fig. I, F) is seen to resemble closely the appearance in the Harvard heart, in which an arrest of development at this stage is complicated by transposition, and on the other hand a comparison of the interior of the reconstruction from the same heart in its normal condition, i. e. unreversed, with the interior of the Holmes' heart, in which the great trunks arise in normal relations, shows strikingly similar features.

The application of this theory of the reversal of the cardiac tube as an explanation of transposition of the arterial trunks in the comparatively large group of cases in which this occurs, uncomplicated by the anomaly seen in the Harvard heart, is less obvious. For, if the reversal be complete, and development proceeds on this basis, one must conclude that, the relationship of all the parts concerned being entirely reversed, no pathological results would ensue, that is to say, the aorta, although placed anteriorly, would continue to drain the left ventricle and the pulmonary artery, although placed posteriorly, would continue to drain the right. The displacement of the orifices relatively to the pulmonary and aortic trunks and to the atrio-ventricular orifices would take effect only when the reversed torsion was incomplete, so that from juxta-position the aorta would be thrown into relation with the mitral orifice and the pulmonary with the tricuspid. That such an incomplete torsion is the underlying cause in the cases of true transposition is borne out by the examination of two cases, kindly loaned to us for purposes of study by Professor W. G. MacCallum in New York, and figured by him in the New York Pathological Society Transactions for 1915. In both these specimens the aorta arises anteriorly and slightly to the right from the ill-developed conus of the right ventricle and passes upward to the arch, while the pulmonary artery arises from the left ventricle, to the left and only slightly posteriorly to the aorta, being

almost on a parallel plane with it. This is not a complete reversal of the two trunks in the sense that although they arise from reversed ventricles they do not take up the relative position normally occupied by each other. An exactly similar external appearance is produced in the embryonic hearts reconstructed, if instead of complete reversing the ventricular portion of the plates, a partial reversal is carried out; such a partial reversal interiorly should have the effect of throwing the aorta into communication with the right ventricle and the pulmonary artery with the left. Two such anomalous models have been made by us, illustrative of an incomplete torsion both of the normal and of the reversed cardiac loop. In both of these cases it may be supposed that the aorta would be thrown into the right ventricle and the pulmonary to the left, although the external relations of the two vessels would differ in each case.

The investigation upon this interesting subject, especially in relation to the interior conditions arising as a result of such deformities is being completed and will be published at a later date.

COARCTATION OF THE AORTA WITH PATENT DUCTUS ARTERIOSUS.† *

CARL VERNON WELLER, M.S., M.D.,

Assistant Professor of Pathology, University of Michigan.

The heart which forms the subject of this report has proven of unusual interest for it is a very good example of that small group of cases of coarctation of the aorta in which the descending aorta appears to be a direct continuation of the pulmonary artery through a large ductus arteriosus, thus simulating, as far as the right side of the heart is concerned, a transposition of the great vessels. Associated with this anomaly and dependent upon it there has been in this case a rather unusual degree of hypertrophy of the right ventricle and a marked chronic passive congestion of the liver such that a typical nutmeg liver is presented in a child dying at the age of twelve days. A moderate degree of thymic hyperplasia was also present.

The mother of Baby C. is married and twenty-three years of age. Her family history is practically negative, as has been her

† Read at the Meeting of the American Section, International Association of Medical Museums, Washington, May 8th, 1916.

* From the Pathological Laboratory of the University of Michigan, Ann Arbor, Mich.

own. It should be noted, however, that she is one of twins and that her twin sister is not in good health. This, her first pregnancy, was normal. She had entered the Obstetric Ward of the University Hospital, service of Dr. Peterson, but finally decided to be confined at home where she underwent a normal delivery and puerperium.

Baby C., a well developed male child, was born January 2, 1916. He remained apparently well until the ninth day when it was noted that he was not well and he was removed to the Paediatric Ward of the University Hospital, in the service of Dr. Cowie. A marked cyanosis and a loud systolic murmur rapidly developed and death occurred on the twelfth day.

At autopsy, the face showed cyanosis and icterus and the conjunctivae were congested. On opening the thorax the thymus was found to measure 6.5 cm. in length, 4.5 cm. in width, and 1.3 cm. in greatest thickness, and both right and left lobes presented definite cervical prolongations. The heart, about twice normal size, lay almost transversely, pushing the diaphragm down and presenting its apex behind the lower border of the fifth rib just outside the left nipple line. The apex of the heart was formed by the greatly hypertrophied right ventricle and a probe introduced into the thoracic aorta passed directly into this chamber, so that at first glance the heart gave the appearance of a true dextrocardia. There were numerous sub-epicardial and sub-pleural haemorrhages and a wedge shaped haemorrhagic area in the upper border of the upper lobe of the left lung. Aside from this area, the lungs were air-containing throughout, but showed a marked congestion and oedema.

The spleen, firm and slightly larger than normal, showed a marked passive congestion. The liver was also markedly congested and mottled purplish and brownish yellow.

Microscopical sections of all organs showed a marked passive congestion but those of the liver were of special interest. The changes here were those of a marked nutmeg liver. The central zones of the liver lobules showed marked necrosis and atrophy and in some there was fibroblastic proliferation. There can be no doubt that the chronic passive congestion productive of these marked tissue changes had been operative previous to the birth of the child.

The heart from this case measures 4.8 cm. in width, 4.2 cm. in length and 3.5 cm. in thickness. The right ventricle forms about three-fourths of the total bulk and itself measures 3.4 cm.



PLATE I. Extreme hypertrophy and dilatation in heart showing coarctation of the arch of the aorta and apparent direct continuation of the pulmonary artery with the descending aorta through a patent ductus arteriosus.



PLATE II. Heart showing complete uncorrected transposition of the arterial trunks. The aorta is seen arising from the right ventricle, the pulmonary artery from the left, and occupying the usual position is the large, thick-walled ductus arteriosus.

in breadth. The right ventricular wall is 7 to 8 mm. in thickness while the left measures but 4 to 5 mm.

As it emerges from the heart the aorta measures 7 mm. in diameter. This trunk gives off an innominate artery 6 mm. in diameter which appears to be a direct continuation of the aorta, while bending sharply to the left a smaller vessel, less than 5 mm. in diameter represents the aortic arch. From this the left common carotid and left subclavian are given off in normal order but are both somewhat smaller than the corresponding vessels on the right. Beyond the point of origin of the left subclavian there is a portion of the aortic arch 5 mm. in length and about 4 mm. in diameter. This enters the arterial trunk made up of the pulmonary artery, the ductus arteriosus and the descending aorta sharply at right angles.

The pulmonary artery is 1 cm. in diameter as it leaves the heart. The ductus arteriosus measures 6 mm. in diameter and this lumen is but slightly increased after the portion of the vessel corresponding to the true aorta is reached.

This specimen illustrates remarkably well the apparent direct continuation of the pulmonary artery with the descending aorta through the ductus arteriosus in a certain proportion of the cases which show some coarctation of the aorta in the region of the isthmus.

COMPLETE UNCORRECTED TRANSPOSITION OF GREAT VESSELS WITHOUT DEFECT IN THE VENTRICULAR SEPTUM.*

CARL VERNON WELLER, M.S., M.D.,
Assistant Professor of Pathology, University of Michigan.

Transposition of the great arterial trunks continues to be one of the most interesting of the congenital cardiac lesions. The great variety in respect to both type and degree which the condition may present, the interesting developmental problems involved and the disproportion so often noted between the marked circulatory disturbance and the relative absence (in many cases) of physical signs have served to maintain and stimulate this interest.

The heart which is here described as falling in this group is that of a male child, Baby X., five weeks' old. The family his-

*From the Pathological Laboratory of the University of Michigan.

tory disclosed certain hereditary stigmata. The child was born at term, well nourished, and without external anomalies. In the course of a few weeks a very marked cyanosis developed and a loud systolic murmur was heard. The child's condition grew rapidly worse, the clinical picture was dominated by the cyanosis and in the last few days life was sustained only by artificial respiration and the administration of oxygen.

At autopsy the child still showed the marked cyanosis. The head had a somewhat hydrocephalic appearance. The fontanelles were large and all the sutures gaping, with cranial asymmetry of the frontal region. The increase in intra-cranial pressure was shown also by the marked flattening of the convolutions. The ventricles, however, were small and the explanation of the increased pressure was found in the marked cerebral and cerebellar congestion and oedema.

The thymus was of normal size. The liver, purplish brown in color, extended three centimeters below the rib margin. The spleen was slightly enlarged and dark purple in color. The bladder was greatly distended, the urachus obliterated and the umbilical vessels showed nearly complete obliteration. Hydrocele in left side of scrotum.

The lungs and heart were removed together as a gross specimen. The visceral pleura was dotted everywhere with small subserous haemorrhages, averaging 3 mm. in diameter. Fewer petechiae were found in the tissues about the thymus and in the adventitia of the great vessels.

The heart measures 5.5 cm. in length and somewhat more than that in breadth because of the enormous distension of the right auricle which was filled with cruor. The cardiac apex is formed jointly by the ventricles which are of approximately the same size and thickness of wall, the left ventricular wall measuring 6 mm. and the right 5 mm. Given off from the ventricles are two large arterial trunks having at their origin approximately the normal relationships of aorta and pulmonary artery. That is to say, the vessel from the right ventricle arises in front and somewhat to the left of the one from the left ventricle. However the right ventricular trunk ascends anteriorly and passes directly into the aortic arch where the branches are given off in the normal order. The left ventricular trunk passes directly backward to give off the pulmonary branches. These trunks are both of good size and of the two the systemic aorta has the thicker and firmer wall, although this difference is not marked. In both cases the arterial orifice is guarded by three cusps which do not show the

anomalous development often found in these cases. As is true in all cases of complete transposition the non-coronary cusp at the aortic orifice is the anterior one. This serves as a convenient means of estimating the extent to which rotation of the aortic septum has failed to take place, this position of the non-coronary cusp diametrically opposite the normal indicating a fault of 180° in rotation.

The ventricles are not reversed. The right ventricle receives caval blood and the left ventricle pulmonary blood. The condition is therefore incompatible with post-foetal life unless there is a persistence of either the foramen ovale or the ductus Botalli on the one hand or anomalous communications between the right and left hearts such as perforate ventricular septum on the other. In this case the foramen ovale is patent only to the extent of admitting a slate pencil, the opening being no larger than often found in the normal infant at five weeks and is, moreover, well covered by the valvula foraminis ovalis. It seems unlikely that there was much interchange of blood through this opening during the last few weeks of life.

The ductus Botalli is still patent but the opening is so small that it admits only a fine probe. From without the ductus appears nearly twice normal size and its wall is greatly thickened. It is evident that the normally occurring obliterative changes have been actively operative here.

The clinical picture presented by this case can be fully explained in the light of the progressive obliteration of the ductus arteriosus. The early period during which the child was in relatively good health was possible because of a free passage of blood through the widely open ductus. With the progressive obliteration the aeration of the blood of the systemic circulation became less and less perfect and the cyanosis progressively more intense. The systolic murmur, likewise, can best be explained as having its origin in the ductus arteriosus.

From the standpoint of congenital cardiac disease, the lesion presented by this case must be classified as a complete (180° degree) uncorrected transposition of the great arterial trunks, without perforation of the ventricular septum, without unusual patency of the foramen ovale and with the fatal outcome precipitated as a result of the physiological obliteration of the ductus arteriosus.

NOTE ON A CASE OF COMPLETE DEFECT OF LEFT
HALF OF DIAPHRAGM, ECTOPIA OF LIVER IN
LEFT THORACIC CAVITY (HERNIA DIA-
PHRAGMATICA SPURIA) WITH PRES-
SURE ATROPHY OF LEFT LUNG.*

ALDRED SCOTT WARTHIN, PH.D., M.D.

(Pathological Laboratory, University of Michigan, Ann
Arbor, Michigan.)

Congenital diaphragmatic hernias depend upon defective development of the diaphragm. Two forms exist: *Hernia diaphragmatica vera* in which a peritoneal sac enclosing some part of the abdominal organs projects through the defect into the thoracic cavity; and *Hernia diaphragmatic spuria* in which the ectopia of the abdominal organs takes place without any peritoneal covering. The latter form is the more common, and occurs usually on the left side in the membranous portion. The defects vary greatly in size, but are often large, and more rarely involve the entire half of the diaphragm. They arise at the time of the separation of thorax and abdominal cavity. Just what causes the disturbance of development in the closure of the communicating opening between thoracic and peritoneal cavities is not yet known; but it is certain that the development of the liver anlage is of the greatest importance in this closure, and also in determining the form and position of the diaphragm. Broman (Verhand. d. anatom. Ges. 1902, Bd. XVI, S. 9) has, in particular, emphasized the importance of the development of the liver to that of the diaphragm.

The following case of total absence of the left half of the diaphragm, with the left half of the thorax completely filled with portions of the abdominal organs, chiefly the very large left lobe of the liver, occurred in our autopsy service, in January, 1915:—

Baby K.—Born at full term, January 25, 1915. Apparently normal infant, but respirations could not be established, and after breathing a few times the infant died. Mother's personal and family history negative. No history of syphilis or of malformations in the family. Three healthy living children. Pregnancy and confinement normal.

Protocol:—Female baby, well-developed, 51 cm. long, general nutrition good. Skin covered with vernix caseosa. Tape about umbilical cord, which is normal. No anomalies of exterior of

* Read at the Meeting of the American Section of the International Association of Medical Museums, May 8, 1916, Washington, D. C.



PLATE I. Total absence of left half of diaphragm; liver in vertical position, the left lobe nearly filling the left thoracic cavity; incomplete rotation of intestines. Full-term foetus.

body. Abundant hair on head, and very abundant lanugo over upper half of body. Moderate hypostasis. Greenish brown meconium coming from anus.

Abundant pale yellow panniculus. Umbilical vessels patent. Muscles very pale. About 100 cc. of clear yellow fluid in peritoneal cavity. The left half of the diaphragm is completely absent; the left lobe of the liver, the splenic flexure of the colon and a portion of the small intestine and stomach lie in the left half of the thorax. The entire liver is so rotated towards the left that it lies almost perpendicularly, its lower border turned to the left side of the body and with the large left lobe filling in the greater portion of the left thoracic cavity, extending to the height of the apex, and moulded to the form of the upper portion of the cavity. The left lobe is much larger than normal, nearly as large as the right one. The position of the liver is such that the groove occupied by the round ligament lies to the left of the ensiform and about in the middle between the two lobes. The lower border of the right lobe extends 4 cm. below the tip of the ensiform and 5 cm. below the ribs in the right nipple line. The diaphragm thins out and disappears in the coronary ligament of the liver. The coronary ligament is unusually long and membranous, and the liver is unusually movable. The spleen is free, and lies anteriorly and below the splenic flexure of the colon which extends into the pleural cavity. It is somewhat larger than normal, otherwise presents no notable features. The intestines show incomplete rotation, the appendix lying just behind the umbilicus with its long coil directed outwards, (about normal fifth month position); the caecum and ascending colon with the hepatic flexure of the transverse colon are crowded into several sharp folds lying in the epigastric region under the edge of the liver in front of the stomach, which lies vertically, extending upwards into the thorax. The left kidney lies at the brim of the pelvis; the right one is just above the brim of the pelvis. Ureters are normal. Adrenals small. Vessels normal.

The heart lies entirely to the right of the median line; and is much smaller than normal; its apex, formed by the left ventricle, points to the right. The vessels are normal. The thymus is short and 1 cm. thick in its thickest portion. It is pushed upwards towards the right of the median line. The pericardial sac is attached to the diaphragm to the right of the median line, and to the right of the coronary ligament. The left lung is represented by two thin rudimentary lobes pressed against the heart and mediastinum. The greatest length of the left lung is 3 cm., the

greatest width 2.3 cm., and the greatest thickness about 6 mm. The lower lobe is transparent, and no thicker than tissue paper. The right lung is very small (7 cm. long, 3 cm. wide) and shows three well-defined lobes.

A more minute examination of the borders of the diaphragmatic defect shows a narrow border of diaphragm 2-4 mm. broad, extending to the left of the coronary ligament. This edge is smooth, rounded, 4-5 mm. thick, and firm as if fibrous. The liver pressed directly upon this edge, and at the point of contact shows some thickening of its capsule. There are no evidences of diaphragm on the left side in the area of usual attachment.

In conclusion, this case presents total defect of the left half of the diaphragm, with a failure of rotation of the liver and part of the abdominal organs downward, so that they appear as if rotated upwards to the left into the thoracic cavity, the greater part of which is occupied by the abnormally large left lobe which pressed upon the left lung, and pushes the heart to the right. An abnormal development of the left lobe with imperfect descent and separation of the liver from the septum transversum and failure of development or pressure atrophy of the left half of the latter might be regarded as the factors leading to this defect.

ON THE DIFFERENCE BETWEEN THE CARBON-DIOXIDE TENSIONS IN THE ARTERIAL AND VENOUS BLOOD AS A DIAGNOSTIC SIGN IN CARDIAC SEPTAL DEFECTS.

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ABBOTT, M.D., MONTREAL.

*(From the Respiration Laboratory of the Peter Bent
Brigham Hospital.)*

From the standpoint of differential diagnosis, as well as from that of the study of the oxygen and carbon dioxide content of the alvcolar air, congenital cardiac lesions may be divided into two classes according to the presence or absence of conditions leading to the development of the familiar symptom-complex of congenital cyanosis.

In the first class may be placed those cases in which, although anomalous conditions prevail in the circulation, these are not of a character to interfere with the aeration of the blood, so that cyano-

sis is characteristically absent, at least until some complicating circumstance introduces an alteration in the course of the circulation, when deficient aeration may occur with symptoms placing the case in the second or cyanotic group. Such cases include all uncomplicated and compensated localized communications between the systemic and pulmonic circulations, such as patent ductus arteriosus and defects of the interauricular or interventricular septa. Under physiological conditions, the pressure is higher in the systemic than in the pulmonic circulation. The result is that at each systole of the ventricles a stream of aerated blood will be deflected from the left into the right ventricle through the defect, whence it passes to the lungs with the unaerated blood from the great veins. That the course of the blood is actually from left to right in this way in these cases of uncomplicated septal defects occurring in fully compensated hearts, is evident not only from physical considerations, but is proved by many pathological experiences, such as the frequent existence of a sclerosed patch on the wall of the right ventricle opposite a defect of the interventricular septum, and the dilatation and sclerosis, often amounting to atheroma, of the pulmonary artery which is especially prominent in defects of the interauricular septum. The result will be an increased amount of blood circulating in the vessels of the lungs, while the conditions in the systemic circulation remain practically unchanged. Secondary results will be a rise of pressure in the pulmonic circulation and dilatation of the right ventricle and pulmonary artery. No reason exists in such cases for deficient aeration.

The second class of cases mentioned above are those presenting conditions leading to deficient aeration and to the consequent development of cyanosis, either in the form of an obstruction to the pulmonary circulation causing a slowing of the stream and a stasis in the systemic reservoir, or an extensive mixture of venous with arterial blood in the systemic arteries, such as occurs in decompensated septal defects with rise of pressure in the right ventricle and in biloculate and triloculate heart. In all these conditions the well recognized symptom complex of congenital cyanosis develops in due course making the diagnosis of a congenital lesion easy. In one of the cases studied by us a double cause of deficient aeration was at work, namely, a pulmonary stenosis obstructing the pulmonary circulation and leading to a slowing of stream and venous stasis and also to a rise of pressure in the right ventricle, and the passage of venous into arterial blood through the coexisting defect in the interventricular septum.

Among this second group of the so-called cyanotic cases is also to be included the late or decompensated stages of many cases of septal defect which for years have belonged in our first or non-cyanotic group described above. In such cases pathological conditions may at any time set in altering the pressure in the systemic and pulmonic circulations, so that the pressure in the right ventricle rises and becomes greater than that in the left. The result of such a rise of pressure in the right heart in these cases, will be that the direction of the current of blood is reversed and the venous stream entering from the great veins passes through the defect to the left ventricle to mingle with the aerated blood sent into the aorta from the lungs. When this occurs in sufficient amount the signs of deficient aeration will present themselves. This happens in many cases of septal defect which become complicated by some intercurrent obstruction in the pulmonary circulation, such as emphysema, or broncho-pneumonia, or in which the pressure may be raised relatively to that in the left ventricle after the onset of failing compensation. Such a "terminal cyanosis" is especially common in patent foramen ovale, and is recognized by the French under the name of *cyanose tardive*.

From the above considerations it is evident that the congenital cardiac lesions in which a diagnostic test will be of the greatest value are those cases of compensated septal defects in which the conditions leading to deficient aeration do not exist and which are characterized by latency of symptoms. And it is in just such cases that the variations in the gaseous tensions offer a differential point.

Such cases frequently present fairly characteristic physical signs which enable a tentative diagnosis to be made, the confirmation of which is of the highest importance in the regulation of the future life of the individual; for such defects although latent, cause a strain upon the heart within the limits of its reserve force which may lead to an unlooked for rupture of compensation, or to the development of an infective endocarditis about the margins of the abnormal opening. It is with this knowledge in mind that the writers present the following method whereby the increase of blood in the pulmonary circulation that must take place in all such clinically obscure cases of compensated and uncomplicated septal defects, may be recognized as a diagnostic feature.

According to the well known gas laws, that the greater the pressure the greater the absolute amount of gas in a given volume, the smaller the pressure the smaller the amount of gas in a given volume, the effective head pressure or carrying power of the blood

may be expressed by the increase in pressure of CO_2 which the blood accumulates in passing through the tissues and which it gives up in turn in the lungs, and the difference between the arterial and venous CO_2 pressure or tension represents this increase in pressure. If it is known by a respiratory exchange experiment how much CO_2 the blood must carry in a given time to the lungs to be eliminated, the amount of blood necessary to transport that gas can be calculated, provided, the arterial and venous CO_2 tension in the blood is known. The usual difference in carrying pressure is known to be 10 mm. in normal subjects. If only a small number of determinations are made the probable error in either determination is 2 to 3 mm. CO_2 tension. If several determinations are made the error decreases in proportion to the number of observations. Therefore, if an increase in carrying tension of the blood is shown to exist, it indicates that a smaller volume of blood is transporting the gas than is the normal or usual condition. Theoretically this should be the case in the cyanotic cases illustrated by our second class, for here the blood is either deflected into the systemic circulation through the defect or is retained in the systemic venous reservoir in the slowing of stream produced by an obstruction at the pulmonary artery. Conversely, if there is a decreased CO_2 carrying tension, as evidenced by a decreased difference in the arterial and venous CO_2 tension below 10 mm., this will indicate that a larger amount of blood was carrying the gas than normally exists. This should be the case in the cases illustrated by Class I in which arterial blood is deflected through the defect into the pulmonary circulation. In either case the variation in the blood flow through the lungs will indicate an equal slowing or an equal increase in both the pulmonary and the general circulations, except where a congenital defect exists between the two systems, when it would indicate, not a change in the entire blood flow per minute, but a relative change corresponding to the difference in the tensions in the pulmonary as compared with the general circulation.

We have investigated four congenital cases, the details of which will be published at length elsewhere, in which the clinical signs and symptoms as determined by the usual methods of cardiac study show consistent agreement with our gaseous determinations as formulated in the principles laid down above. We believe, therefore, that this method of determining the tension of CO_2 in the arterial and venous blood and of thus noting the difference in the carrying tension of the blood can be used as a valuable aid in the diagnosis of those cases of congenital heart disease

in which there is some doubt as to the exact interpretation of the usual signs and where the presence of cyanosis does not supply a diagnostic feature, namely of those cases of communication between the two circulations in which the pressure in the left ventricle being higher the arterial passes into the venous blood from left to right through the defect.

The idea that the variations between the gaseous tensions of the arterial and venous blood could be used in the diagnosis of septal defects was first suggested by Plesch¹. He, however, used the O₂ tensions. On account of the variations in the disassociation curve of oxyhaemoglobin by various factors, it is less easy and less exact to calculate the minute volume of the circulation from a knowledge of the potential difference in the oxygen tensions, especially as many of the cases examined will be the subject of cyanotic change. Moreover, the estimation of the oxygen in alveolar air is difficult for the patient and can only be used by an expert operator. For these reasons, both because the estimation of the CO₂ differences is easier for the operator, and because it is absolutely safe for the patient, it is to be preferred to the method suggested by Plesch.

The method followed by us for obtaining the CO₂ tension was that recommended by Lindhard in which a Krogh spirometer containing a mixture of carbon dioxide and oxygen approximating that in the patient's alveoli is used and is described by Boothby and Sandiford in the *American Journal of Physiology* for March, 1916. The arterial tension was obtained as usual by the Haldane method. Both procedures are simple and are applicable to practically all the cases presenting themselves for study.

Our thanks are due to Dr. Henry Christian for the privilege of studying and reporting cases from his service at the Peter Bent Brigham Hospital.

¹ Berlin. klin. Wochenschr., 1909, xlv, 392, and 1910, lxxiv, 230.

CORRESPONDENCE

ON ESTABLISHING A SOURCE OF SUPPLY OF SQUARE GLASS MUSEUM JARS.

The following copy of a circular letter issued to the Museums of the British Empire by the Museums Association of Great Britain, is of interest to our readers in connection with the attempt that is now being made by the American Section of the International Association of Medical Museums along similar lines to establish a source of supply of square glass museum jars on the American Continent. This matter is discussed in this Bulletin, both editorially and under the report of the Washington meeting of the American Section:—

THE MUSEUMS ASSOCIATION.

HON. TREASURER:

H. LANGTON, M.B.O.U., 61 Dyke Road, Brighton

HON. EDITOR:

W. R. BUTTERFIELD, The Museum, Hastings.

HON. SECRETARY:

E. E. LOWE, B.Sc., F.L.S., The Museum, Leicester.

MUSEUM AND
ART GALLERY,

LEICESTER.

March 7, 1916.

DEAR SIR:

Acting on instructions from The Museums Association, I have been trying for some months to find a British source of supply of rectangular glass specimen jars, but find that manufacturers are unwilling to take the matter up. I have reason to believe, however, that if a definite and substantial order could be placed, it would be possible to persuade glass-making firms to consider the matter more favourably, and I write to ask whether you will pledge your institution to take say £10 of the following sizes, mixed:—

Height	Width	Back to front
6 in. x	4 in. x	2 in.
8 in. x	6 in. x	2 in.
10 in. x	8 in. x	3 in.
12 in. x	8 in. x	4 in.
24 in. x	8 in. x	4 in.

The specifications would call for regular thickness, absence of colour, one side polished, top edges ground flat, and a flat lid with edges ground to fit.

If you cannot take £10 worth, please say how much you are prepared to spend, even £1 would be of use, bearing in mind that this to be viewed chiefly as an attempt to get an industry established in England, and *not* as an occasion for getting precisely the jars individually required, and no others, at bargain prices.

Before any order was definitely placed I would supply each museum with a quotation for approval.

If you can devote more than £10 to the purpose, so much the better.

This circular letter goes to the heads of all the principal Museums in the British Empire, and I trust it will receive prompt and serious consideration.

If there are any other materials, appliances, models, specimens, or anything else connected with museum work which you now have difficulty in obtaining, I should be glad if you would let me know so that the matter may be brought before The Museums Association with a view to securing supplies.

I am, Dear Sir,

Faithfully yours,

E. E. LOWE,

(Hon. Secretary.)

ON A METHOD OF AFFIXING STEEL LABEL HOLDERS TO GLASS MUSEUM JARS.

The following extract from a letter received on October 9th, 1915, referring to the very useful label holders described and figured in this Bulletin, page 36, is of interest.

DEAR DR. ABBOTT:—

In my article on Medical Museums in the Jefferson Medical College and Hospital Publications, Vol. VI, I stated that the label holders were fastened on with letter wax. We have found that sometimes the wax does not hold and it has been difficult to discover the reason. The label holders may be secured by touching the glass with a little hydrofluoric acid, or with a corundum stone; or if neither is convenient the glass may be thoroughly cleaned and a paper gummed label applied to the glass; to this the hot wax and holder will adhere.

The paper label acts as a binder and the wax which runs over the sides of the label protects it from water in ordinary cleaning of the jar. A note with regard to this simple method might be incorporated in the next Bulletin if you think it is worth while. With kindest regards, I remain

Sincerely yours,

(Signed)

W. M. L. COPLIN.

DEPARTMENT OF EXCHANGES

One of the most important functions of this Association is the development of an international system of exchange of museum specimens and pathological material for microscopic investigation. This exchange is conducted by means of correspondence, a circular letter being sent out from time to time by the Secretary, requesting a statement of material wanted and material offered in exchange. In addition members are invited at any time to address the Secretary for material wanted. All such announcements and requests will be published in the succeeding Bulletin or made in the interval of publication by means of a printed circular. The following are the

CONDITIONS OF EXCHANGE.

1. The exchange may be transacted either through the Secretary or directly between the giver and the recipient. Before any material is sent out to any applicant he must be notified of the intention of the proposed donor, in case his request has already been granted by some other member of the Association.
2. The cost of transportation is in all cases to be paid by the institution receiving the material transported.
3. If the specimens are very small, they may be sent by post. Large specimens should be transported, not in individual glass jars, but in bulk, wrapped in moist absorbent cotton, and packed in soldered tin or other water-tight receptacle.
4. Each specimen should be tagged with its reference number, written in India ink on tape (preferably paraffined).
5. A statement of the nature of the specimen and, where possible, a brief history of the case, should be forwarded to the recipient.

Members of the American Section are earnestly requested to help forward the good work of the Association by responding to the appeal for material below made by two members of the Association, who are organizing new museums, and are greatly in need of gross specimens for teaching purposes illustrating all the commoner lesions.

EXCHANGES PROPOSED.

Professor Aaron Arkin, Department of Pathology and Bacteriology, West Virginia University, West Virginia.

Requests:

Kidneys, representing various forms of nephritis, tuberculosis, pyonephrosis, etc.

Liver sections of various forms of cirrhosis, tumors, etc.

Tertiary lesions of syphilis suitable for mounted specimens.

Tuberculosis of various organs, especially genito-urinary tract, central nervous system.

Sarcomas and carcinomas of various organs.

Typhoid ulcers of intestine, amoebic lesions.

Intestinal parasites.

Hearts showing endocarditis, myocarditis, pericarditis.

(Expenses for shipment of all specimens will be gladly paid. On account of lack of hospital material the above will be of great help, and any specimens sent will be appreciated.)

Dr. A. G. Nicholls, Professor of Pathology, Dalhousie University, Halifax, N. S., requests donations of Pathological Material to fill up gaps in series in his Museum. The following specimens, of a kind adapted for teaching purposes, are particularly needed:—

Heart and Blood Vessels:—

Valvular lesions of all kinds.

Myocardial fibrosis.

Myomalacia.

Ball thrombus in left auricle.

Dissecting aneurysm of aorta.

Lung:—

Tuberculosis in all forms.

Infarct.

Bronchopneumonia.

Spleen:—

Infarct.

Leukaemia.

Amyloid.

Liver:—

Hob nail.
Acute yellow atrophy.
Cirrhosis with gall-stones.
Primary carcinoma.
Sarcoma.

Kidney:—

Sarcoma.

Bones:—

Injuries.
Inflammatory conditions.
Tumours.

Any of the above will be gratefully received and all charges paid. Kindly address them to *Pathological Laboratory, Morris Street, Halifax, N. S.*

REPORTS

REPORT OF THE NINTH STATED MEETING OF THE AMERICAN SECTION OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS, MAY 8TH, 1916.

The ninth meeting of the American Section of the International Association of Medical Museums took place at the Army Medical School, Washington, D. C., on Monday, May 8th, being the day preceding the meeting of the Congress of American Physicians and Surgeons, at 10 a. m. and 2:30 p. m. Professor A. S. Warthin, of Ann Arbor, Michigan, was in the chair, and there was a good attendance, including Drs. W. M. L. Coplin, Louis B. Wilson, O. Klotz, S. R. Haythorn, A. T. Henrici, C. V. Weller, M. C. Winternitz, H. E. Robertson, H. Karsner, Mary E. Bogan, J. Kaufmann, Eiselberg, R. A. Lambert, H. U. Williams, A. Arkin, H. K. Craig, J. R. Scott, C. J. Bartlett, M. E. Abbott, H. T. Marshall, and others.

The following officers of the American Section were elected for the ensuing year: *President*, Professor O. Klotz, Pittsburg; *First Vice-President*, Professor W. M. L. Coplin, Philadelphia; *Second Vice-President*, Professor H. E. Robertson, Minneapolis; *Third Vice-President*, Dr. D. S. Lamb, Washington, D. C.; *Councillors*, Professor A. S. Warthin, Ann Arbor, Michigan; W. M. L. Coplin, Philadelphia, Pa.; Howard Karsner, Cleveland, Ohio; M. C. Winternitz, Baltimore, Md.; R. A. Lambert, New York; *Secretary-Treasurer*, Dr. Maude E. Abbott, Montreal; *Assistant Secretaries*, Drs. Joseph Kaufmann and W. W. Francis, Montreal.

The following members were recommended by the Council and were elected by the vote of the American Section taken at this meeting: Drs. W. T. Councilman, Department of Pathology, Boston, Mass.; E. C. Royce, University Hospital, Iowa City, Iowa; M. J. Couret and H. W. Wade, Tulane University, New Orleans, La.; A. G. Nicholls, Dalhousie University, Halifax, N. S.; M. M. Miller and Jas. W. Jobling, Department of Pathology, Vanderbilt School of Medicine, Nashville, Tenn.; Mary E. Bogan, Department of Pathology, Baltimore, Md.; A. Freedman, De-

partment of Anatomy, and E. J. Mullally, Department of Pathology, McGill University, Montreal; H. K. Craig, George Washington University Medical School, Washington, D. C.; Arthur T. Henrici, Department of Pathology, University of Minnesota, Minneapolis, Minn.; Aaron Arkin, Department of Pathology, West Virginia University, Morgantown, W. Va.; B. S. Kline, Montefiore Hospital, and Louis Smirnow, College of Physicians and Surgeons, New York City, N. Y.

The following programme was presented and supplied subjects for much interesting discussion of methods, technique, and objects of research:

DISCUSSIONS.

1. *On the organization of the South American Section.*—R. M. Pearce, Philadelphia; A. S. Warthin, Ann Arbor.

A letter written by Professor Pearce, retiring President, was read, from which it was evident that owing to the effect of the war upon the South American countries, the time for the extension of the activities of this Association in that direction has not arrived.

2. *On the standardization of sizes of square glass museum jars.*—W. M. L. Coplin, Philadelphia; R. L. Thompson, St. Louis; E. L. Judah, Montreal.

3. *On the manufacture of square glass museum jars, and the problem of establishing a source of supply under existing conditions.*—M. C. Winternitz, Baltimore; E. L. Judah, Montreal; M. E. Abbott, Montreal.

An important discussion took place on the standardization of square glass museum jars and the problem of obtaining a source of supply of these under existing war conditions. The subject was one of great general interest since a very large demand for such jars existed in the various museums represented by members of the American Section, which could no longer be met by Continental sources of supply, so that orders to the amount of thousands of dollars worth could readily be placed with any firm willing to undertake their manufacture, which could produce evidence that these would be even moderately satisfactory. The difficulties in the way of their home manufacture were set forth by Dr. Coplin, who had made extensive enquiries on behalf of his own museum with very depressing results, and had been unable to get any firm to take up the work. Among other obstacles he pointed out that the wooden moulds formerly used in the manufacture of these jars by the German firms could not be supplied by the class

of labor available in this country, and that a metal mould must be substituted; the jars thus made had a tendency to be very thin at the corners, and therefore, to crack on sealing. A more optimistic view of the situation was taken by Drs. Klotz, Warthin, Winternitz, Robertson, and others. Drs. Klotz and Winternitz had been in communication with two different firms, and had reason to believe that a suitable supply could be obtained from one of these if the demands were presented in proper form. The necessity of simplifying the problem by reducing the large number of miscellaneous sizes now in use was emphasized, and a report from the Committee on Standardization of Sizes, consisting of Drs. Coplin and Thompson, and Mr. E. L. Judah, was received, which proposed reducing this number for present purposes to some sixteen sizes. The Secretary submitted circular letters from Mr. E. E. Lowe, of the Museums Association of Great Britain, dealing with the same problem and inviting subscribers for £10 or less, in order to lead the way to inaugurate a source of supply. The feeling of the meeting, however, was in favor of establishing a source of supply on this continent if this were possible, and steps were taken for this purpose, in the following resolution:

Resolved, That a Committee upon establishing a source of supply, consisting of Drs. Klotz, Winternitz, and the Secretary, be appointed, who should first confer with the Committee on standardization of sizes and decide upon a set of some eleven to sixteen standard sizes and should then proceed to obtain terms from those manufacturers willing to undertake this manufacture on the one hand and those members desiring jars on the other, and thus endeavour to establish an American source of supply.

PAPERS AND DEMONSTRATIONS.

Museum Technique:

4. *A new museum jar for the preservation of eye specimens.*—Henry Albert, Iowa City. (Published in this Bulletin).

5. *Concrete museum jars and other concrete containers for museum work.*—W. L. M. Coplin, Philadelphia.

6. *Some suggestions for properly equipping a Post-Mortem room. Illustrated.*—H. E. Robertson, Minneapolis. (Published in this Bulletin).

7. *The application of the methods of cross section anatomy to museum work, with photographs.*—W. M. L. Coplin, Philadelphia.

8. *The use of the Lapidary's saw, and discussion of other methods of sectioning and polishing calculi.*—W. M. L. Coplin, Philadelphia.

9. *A satisfactory method of preparing sections of teeth with the soft tissues in situ, with lantern demonstration, and illustrative specimens.*—Arthur T. Henrici, Minneapolis. (Published in this Bulletin).

10. *Mounting specimens under Petri dishes and clock glass.*—E. L. Judah, Montreal. (Published in this Bulletin).

11. *A mounting fluid for gross specimens in natural colours, with demonstration of illustrative specimens.*—Oskar Klotz, Pittsburg. (Published in this Bulletin).

In the discussion Dr. Haythorn said that he had obtained beautiful results by following this method, but he had of late omitted the sugar solution entirely as he found that it tended to the growth of moulds. Dr. Coplin stated that he preferred the old Kaiserling method to which he always returned.

12. *The role of organic acids in preservation of museum specimens.*—H. E. Robertson, Minneapolis. (Published in this Bulletin).

Dr. Winternitz asked whether the formalin used was neutral, and said that he was in the habit of neutralizing formalin before using it by putting marble dust in the jar. Dr. Warthin said that a tendency to acidity of the formalin constituted a real difficulty.

Microscopic Technique:

12. *Substitutes for cover glasses.*—Carl V. Weller, Ann Arbor. (Published in this Bulletin).

13. *A modification of Mallory's aniline blue stain for connective tissue.*—S. R. Haythorn, Pittsburg. (Published in this Bulletin).

14. *A comparison of staining methods used in the study of pathological lesions in the sympathetic ganglia, with lantern demonstration.*—Louis B. Wilson, Rochester. (Published in this Bulletin).

15. *The cytology of normal goats' blood, with lantern demonstration.*—Georgine Luden, Rochester. (Published in this Bulletin).

This paper was discussed by Drs. Warthin and Wilson. Dr. Luden's attempt at establishing the morphological conditions of the goats' blood was recognized as being of great importance,

owing to the value of this animal in laboratory work, and the illustrations shown were declared to be extremely interesting and exhibited a beautiful technique.

Objective Presentation of Results of Medical Research:

16. *A report of three cases of Madura foot disease.*—A. S. Warthin, Ann Arbor.

17. *Mature adipocere from pig and human subject with statement of complete chemical analysis (the first made).*—R. F. Ruttan, Montreal. (By invitation). (Published in this Bulletin).

18. *Demonstration of the types of lesions in the liver in chronic passive congestion, illustrated by gelatin plates, microscopic sections, and chart.*—R. A. Lambert, New York. (Published in this Bulletin).

In the discussion Dr. Marshall expressed himself as much interested in this subject. The evidence of oedema in chronic passive congestion had been noted by himself, and he believed that oedema probably precedes the haemorrhage. Dr. Warthin thought that the various types of lesion shown were differences of degree, and that haemorrhagic necrosis represents the most severe form of cell asphyxia due to intense passive congestion. He had seen the same phenomenon in arsenical poisoning and explained it as the result of intense cyanosis; and had had several cases of distinct marked fibrosis.

19. *Study of an unusual case of congenital cystic kidney of enormous dimensions.*—E. Latreille, Montreal.

20. *Double monster of Janus type (Cephalo-thorocopagus monosymmetros cyclops synotus.)*—M. E. Abbott and J. Kaufmann, Montreal. (Published in this Bulletin).

21. *Congenital malformation: Absence of left half of diaphragm, agenesis of left lung, liver in left thoracic cavity.*—A. S. Warthin, Ann Arbor. (Published in this Bulletin).

22. *Congenital anomaly of heart.*—Carl V. Weller, Ann Arbor. (Published in this Bulletin).

23. *Diagrammatic presentation of the respiratory exchange in two types of cardiac malformations.*—Walter M. Boothby, Boston, and M. E. Abbott, Montreal. (Published in this Bulletin).

A fine exhibition of pathological material and objects illustrating various stages in medical research, given in detail below, was on view and remained open during the three days of the Congress for the benefit of the members of the American Association of Pathologists.

Special Exhibits with Demonstration:

24. From the Army Medical Museum, Washington, D. C.—
 - (a) Monstrosities. Series demonstrated by D. S. Lamb.
 - (b) Tropical Diseases. Gross and Microscopical Material illustrating Lesions of Yellow Fever, Malaria, Balantidium Ulcer of Intestine, Beef Heart with Onchocercus gibsoni, Schistosomum japonicum, Cultures of Leishmania infantum and stained smears of the same, Leishman-Donovan bodies of Kala-azar, Blood smears with the stained organisms of Trypanosoma gambiense.—Major E. R. Whitmore, J. R. Scott, D. S. Lamb.
25. From the College of Physicians and Surgeons, New York.—*Transposition of the Arterial Trunks*.—W. G. MacCallum.
26. From the George Washington University Medical School, Washington, D. C.—*Series of specimens prepared by exhibitor's own method*.—H. K. Craig.
27. From the McGill Medical Museum, Montreal.—*Cardiac Anomalies; Monstrosities (Janiceps; foetus acornus)*.—J. Kaufmann, Montreal.

Exhibits illustrating papers presented at American Association of Pathologists:

28. *A peculiar form of lipoma*.—H. E. Robertson, Minneapolis.
29. *Series of reconstruction models of heart from human embryos, 2.4 mm. and 10 mm. long, showing (a) normal organ, (b) Reversed torsion of ventricular bend, also specimens of cardiac anomalies*.—F. T. Lewis, Boston, and M. E. Abbott, Montreal. (Abstract of paper is published in this Bulletin).

FINANCIAL STATEMENT OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS.

From April 1st, 1915, to April 28th, 1916.

(Being the Report submitted to the Washington Meeting of the American Section, and accepted May 8th, 1916.)

Cr.

April 1/15. Balance in bank		\$390.12
Received in members' fees:		
April 1st-May 12th, Folio 72.....	\$ 24.40	
May 13th-Nov. 1st, " 74.....	52.30	
Nov. 4th-Feb. 28th, " 76.....	36.20	
Feb. 28th-Mar. 15th, " 78.....	44.35	
Mar. 15th-Apr. 10th " 80.....	46.35	
Apr. 14th-Apr. 25th, " 82.....	10.10	213.70
Received from sale of Bulletin		1.00
Interest on Strathcona Fund, July 7th, 1915.....	\$150.00	
" " " " Mar. 7th, 1916.....	150.00	300.00
Bank interest to date:		
May 31st, 1915	\$ 4.05	
Nov. 30th, 1915	7.72	11.77
Expense credit (stamps on hand)		1.55

Dr.

Stamps and postal cards	\$ 19.79	
Telegrams, Special Delivery Letters	2.95	
Discount on cheques	6.16	
Petty cash, paper, etc.	1.51	
Expenses of St. Louis Meeting	25.00	
Express, Blaiklock Bros.	5.80	
Bulletin V	495.52	
Printing:		
Programmes and Circulars, 1914.....	22.15	
" " " 1915.....	17.50	\$596.38
Balance in bank	321.76	
		\$918.14 \$918.14

THE
INTERNATIONAL ASSOCIATION
OF
MEDICAL MUSEUMS

BULLETIN NO. VII.

SPECIAL WAR BULLETIN OF AMERICAN AND
CANADIAN SECTION

EDITED BY

ALDRED SCOTT WARTHIN, M. D.
CARL VERNON WELLER, M. D.
ANN ARBOR, MICHIGAN.

MAUDE E. ABBOTT, M. D.
LOUIS GROSS, M. D.
MONTREAL, CANADA.

ISSUED AT ANN ARBOR, MICHIGAN, U. S. A.
AND MONTREAL, CANADA
May, 1918

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The International Association of Medical Museums

BULLETIN NO. VII.

Special War Number of American and
Canadian Sections

EDITED BY

A. S. WARTHIN,
C. V. WELLER,
ANN ARBOR.

AND

MAUDE E. ABBOTT,
LOUIS GROSS,
MONTREAL.

EDITORIALS

RETROSPECT OF THE PATHOLOGY OF WAR.

The three and a half years of the great World War have given much that is new to Medicine as well as to Military Science. Indeed, the tremendous changes in methods of warfare are in themselves responsible for the development of entirely new pathological conditions and diseases. The new types of projectiles and missiles employed, the intensive use of grenade, shell and bomb have given new aspects to the wounds of war and the surgical treatment thereof. Traumatic Surgery has been especially enriched. The aid of all branches of medical research has been invoked in this field alone; operative surgery and medical treatment for the trauma itself, bacteriology and immunology for the prevention of infection or its neutralization, chemistry and pharmacology for the use of new methods of antiseptics, experimental pathology for the prevention of shock, and for the reparative and reconstructive after-treatment, and neurology and psychiatry for the treatment of the nervous traumatisms. In each field some new experience of value has been gained, some notable facts observed and recorded. An important chapter of knowledge, practically unknown before, has been added concern-

ing the effects of artillery upon the nervous system, not only the direct traumatism of central nervous system and peripheral nerves but particularly those disturbances of the former known as "concussion", "commotion", or "shell-shock". Closely connected with these conditions are the effects of modern methods of warfare upon the ears, and the prevention of such ear-damage has become a matter of great importance. The development of gases and liquid fire has given a chemical aspect to this war previously undreamed of; and the pathology and therapeutics of "gassing" are at the present moment chapters whose first pages are just being turned. Trench warfare has given us "Trench Fever", "Trench Foot", "Trench Shin", "Trench Belly", "Trench Icterus", "Trench Kidney", etc.; and with these new names there have come also new and important acquisitions of knowledge. In the field of infectious diseases alone most valuable nosographic and therapeutic progress has been achieved, not only with respect to infections particularly associated with warfare, but also to infections showing a changed aspect under war conditions. Likewise, certain affections of the heart, lungs, kidneys, adrenals, and liver have presented new aspects under the conditions of warfare. Back of the actual field of action with its manifold medical aspects is the effect of the war upon the civilian population, particularly with reference to occupational diseases of munition and aeroplane-workers. Changed conditions of nutrition may well form another chapter still to be opened.

The pathology of War has, therefore, during these three and a half years become a field of paramount interest and importance. Its literature is already voluminous, in spite of the fact that many of the foreign medical journals have suspended publication. Thanks to the numerous medical articles already published there exists in the literature a large body of knowledge yet to be arranged, correlated and critically digested. Many of the articles upon various medical aspects of the war are of little or no value; they represent the individual observations of military medical officers of little experience and less medical knowledge. There is much repetition; some of these writers have published the same observations in half a dozen different places, more or less. Much "library research" is needed to separate this chaff from the real grains of value scattered through the mass of literature. As yet there has been but little effort made to do this. Some of the medical journals abstract certain war articles as they appear; others have columns or sections devoted to military medicine in which abstracts, short reviews or original articles

appear; but very few articles have appeared in which the literature of any one subject in military medicine is summarized approximately fully and critically analyzed and digested. In France the "*Revue Générale de Pathologie de Guerre*" has attempted to do this for French medical literature. In the five numbers that have appeared the French articles for the first two years of the war have been thus treated, with reference to the following subjects: No. 1, *Les Déviations de la Colonne Vertébrale; Le Campto-rachis, Paralysies Réfléxes, La Meningite cérébro-spinale Epidémique et ses Acquisitions Récente, Revue de Cardiologie de la Guerre*; No. 2: *Les Etats Dysenteriformes et les Dysenteries au Cours de la Guerre, Les Glandes Surrénales en Pathologie de la Guerre, Le Pied des Tranchées, Les Commotions des Centres Nerveux par Éclatement D'obus*; No. 3: *Les Troubles Nerveux Tardifs Consécutifs aux Traumatismes Crani-cerebraux de Guerre, Les Troubles de la Parole et les Commotions de Guerre, La Rachnologie de Guerre*; No. 4: *Récents Acquisitions Clinique sur la Fièvre Typhoïde, Étude Clinique des Infections Paratyphoïdes, Le Procédes de Laboratoire dans le Diagnostic des Infections à Bacilles Typhique et Paratyphiques*; No. 5: *Vénérologie et Dermatologie Depuis la Guerre, le Poutmon de Guerre, les Néphrites de Guerre*.

What this *Revue* has attempted to do with French war literature should be accomplished for the entire war medical literature of all nations. The medical experience of these three and a half years should be brought together, digested and systematically arranged for English-speaking allies, as upon them is to fall the chief burden of finishing this stupendous struggle for human liberty and democracy. The entrance of America into the War is the psychologic moment for the assembling of all the military and medical experience of the War to date. The new American Army should in every way be made to profit by such experiences. It is essential from the standpoint of medical preparedness that all that is new in a medical way arising out of this War up to the present time should be made available as soon as possible for the benefit of this new Army. As far as the literature is concerned this should be done at once, to serve as a foundation for experimental and research investigation.

One of the chief functions of this association is the collection and preservation of objective material and specimens to be used for demonstration and teaching purposes. The need of doing this in the present War was seen at the very start by Drs. Adami and Keith. As shown in the editorial following this an

objective medical record of this great Conflict has already been assembled in the Royal College of Surgeons, and a consignment of similar material has already been made to the Canadian Army Medical Corps Museum. Suitable preparations should be made by the United States authorities so that the Army Medical Museum at Washington and the leading Medical Schools of the country should receive similar collections illustrating the medical side of the present war. The officers of this Association have not been slow in recognizing the importance of this; and at the meeting in New York, last April, the services of the Association were offered to the United States Government towards the fulfillment of this purpose. The matter, unfortunately, rests there. If the museum experience of the members of this Association cannot be utilized by the American government, the Association can still be of great service by assembling, arranging and correlating the medical experiences of this War. Such work I take to be included in our aims and functions.

We have particularly emphasized the importance of creating a Museum of Medical Research in which the material used in the investigation of medical problems can be preserved for the use of other workers. The historical importance of such collections is of the greatest. Today in the complicated chemical and physical conditions of modern warfare medical history is being created every day, in the form of new pathology, new diseases, new affections. Each one of these new medical conditions means new investigations and new researches, and the records of these should be kept. It is the duty of this Association to see that they are kept. The necessary foundation for such museum collections is the collecting of all available data concerning the material to be collected and preserved; and especially at this important stage of the war—the critical stage perhaps—should such data be made available. It has, therefore, seemed, that, at the present time the Association could do no greater good than by attempting, what has not yet been done by any other agency, the collection and analysis of the new medical material of this war, and make the new knowledge immediately available to the medical corps of the new American army. It was with this idea that the Retrospect which this War Bulletin contains was planned; and in it we present summaries of the most important and newer medical features of the war. We have not, by any means, been able to cover completely the ground; the field is too large to be covered in one Bulletin of this size; but the importance of the subjects treated, and the full bibliographies given cannot but give

to this Bulletin an especial value. Taken in connection with the French *Revue* as a supplementary work it cannot fail to be of great help to the many investigators working on the medical problems created by the war. At least such is our hope.

Aldred Scott Warthin.

*THE GREAT WAR EXHIBIT AT THE ROYAL COLLEGE
OF SURGEONS OF ENGLAND, AS REFLECTED IN
A HANDBOOK BY DR. ARTHUR KEITH.*

Probably no event in the evolution of the present War is of greater scientific value, or more productive of lasting benefit to this and later generations than the remarkable exhibition of War specimens now going on at the Royal College of Surgeons in London, which was thrown open to the public on October 11th last by Sir Alfred Keogh, Director-General of the British Army Medical Forces. A small handbook* to the exhibit describing its salient points and the development of the collection adds greatly to its value, and is written by Dr. Keith, Conservator of the Museum, to whose executive genius the arrangement of the exhibition in its present form is largely due. From it the following facts, which are of great interest to the members of this Association, are gleaned.

The collection on exhibition is a result of the activity of the British Medical History Committee, which was organized in November, 1914, and which from its inception has recognized as one of its first duties "to collect examples of the wounds and diseases suffered by soldiers in the present war; to dissect and examine such specimens in order to fully understand their extent and nature so that the best means for their treatment might be adopted; and to preserve instructive examples so that they might be examined and studied not only by Army surgeons of today, but also by medical men for many generations to come." "Such specimens," in Dr. Keith's words, "are original documents; they constitute an original and reliable source of knowledge for all time", and supply the most valuable basis possible for present and future medical and surgical treatment of the diseases and injuries of war.

* Republished with a full account of the Addresses given at the Opening of the War Exhibit, in the *British Medical Journal*, October 20, 1917.

In May, 1915, the Medical History Committee called the Council of the Royal College of Surgeons to its assistance and shortly thereafter memoranda were issued to all officers in charge of Military Hospitals and Casualty Clearing Stations requesting the collection of material illustrating the pathology, modes of healing and results of treatment of injuries in the present war, and giving directions for their preservation, attachment of records, and despatch. In January, 1916, the collections in France were placed under the special oversight of Lieut.-Colonel Elliott, F. R. S., with highly satisfactory results, and in the spring of 1917 Lieut.-Colonel Sir John Bland-Sutton was appointed to organize those from the military hospitals in England.

The wealth of pathological and surgical material that has poured in from the Imperial forces at all points of the Allied Front in response to these efforts was at first merely housed and indexed at the Royal College of Surgeons, with a view to the working of it over by experts at the close of the War; but the feeling grew, and was finally expressed by Sir Arthur Sloggett, Director-General of the British forces in France, that such collections possess an immediate educative value for the Medical Officers serving today, and should therefore be open to their observation and study now. Arrangements were accordingly made for their display, and three large halls of the Museum, which had been left empty early in the War by the transfer of their historical contents (which were preserved in combustible alcohol) to the basements to avoid danger from air-raids were given over for their accommodation. The whole energies of the depleted museum staff with the assistance of a number of willing collaborators were turned upon the preparation of this material, which is now shown interspersed with photographs, sketches, paintings, and casts of war conditions incapable of more direct preservation, and placed in instructive juxtaposition to groups of historical material derived from the Crimean, Franco-Prussian and other wars, and to local exhibits of therapeutic and other appliances from smaller military hospitals in England. The first impulse of the observer is one of regret that a larger amount of material, relatively speaking, had not been preserved from previous campaigns for comparison: the next is a realization of the immense permanent value of these records of facts gained by experience and experiment during the present world crisis and cataclysm.

The real nucleus and essential part of the exhibition is a series of extremely fine dissections made by Mr. S. G. Shattuck,

F. R. S., Pathological Curator, and Mr. Cecil Beadles, Assistant-Curator of the Museum, and exhibited in Room II, of the collection. Each specimen represents an exact investigation made in such a way as to permit the visitor to gain at a glance results which have taken the investigators laborious pains to elucidate. Such specimens add the value of a research into the course and treatment of wounds of the soft parts to the collection. Less than a tithe of the material in hand has been so thoroughly dissected, but the main characters of modern gunshot wounds can be studied also in a great number of other specimens that are also carefully prepared, the collection of gunshot wounds of the chest, lungs, and pleura with their sequelae being especially interesting. Gunshot wounds of the bones and joints have been under the special charge, for selection and cataloguing, of Dr. Keith, and the beautiful series of macerated specimens of these lesions are nearly all the work of Sergeant F. Izzard of Cambridge, one of the organizing members of this Association.

Other series of much interest show the lungs of men who suffered from the first poisonous gas sent over the British Canadian troops at Ypres in 1915, in the various stages of both early and late effects; the disorganization of the various organs by *B. aërogenes capsulatus*; kidneys in trench nephritis, etc.

A feature of extreme interest in the exhibit, which of course has been drawn from the Imperial troops at various points of the British Front, is the pooling of certain rare experiences in surgery which throw light upon each other, and which without such a central Army collection of pathological specimens could never have been brought together. In illustration may be cited three cases, coming from different units, in which a piece of metal was found within the heart chambers, without any injury of the heart wall, and a fourth in which the bullet was removed from the lumen of the inferior vena cava on its way to being swept on into the heart—the last specimen thus giving the clue to the path taken by the metal in the other three cases.

The Imperial nature of the collections is emphasized, for it has been the object of the Medical History Committee to support and foster the development of Army Medical Collections in the various countries fighting under the British flag, and specimens sent in from Canadian, Australian, New Zealand or other forces are ear-marked for their ultimate destination in the hospital or university from which the unit collecting them has been drawn.

It is clearly understood that this is but an interim exhibit, and in spite of its large size and imposing character it is seen at a glance to be incomplete. New accessions are constantly coming in, new dissections are being made, and new preparations mounted, and large blanks or spaces are seen between the series inviting further contributions. This is especially the case in Room III, in which exhibits from local hospitals showing therapeutic appliances and their results are placed. But enough is shown to demonstrate to the most uninitiated the immense value of such a carefully studied objective presentment of facts. And the whole is a monument to the enthusiasm, skill, and devotion of Dr. Keith and Mr. Shattuck and their colleagues in the Museum, and collaborators in the Field. If the collection is carried further along the same lines, and this will undoubtedly be the case, a British collection will be erected that will be unsurpassed in quantity of material, and in skill of dissection, good preservation and adequate description, comparing with the other great museums of England, which is the acknowledged home of Medical Museum work.

What has the American and Canadian Section of this Association to learn from the graphic account given by Dr. Keith of this great British War Exhibit, and what part may it expect to take in the wholly similar activities which will soon engage the attention of the Army Medical Services of this continent? A Canadian Army Medical Exhibit is already assured by the broad policy of the British Imperial Government; and, in the face of the splendid organization by which the United States Government is meeting all the emergencies of the War we may feel sure that the action taken by the British Medical History Committee will be duplicated at Washington in a great American exhibit. This is further secured by the facts of American history, for it was in just this way, as the basis for the Medical History of the Civil War, that the great Army Medical Museum of Washington arose; and it was undoubtedly the formation of this great institution that pointed the way for the organization of the British Medical History Committee in the autumn of 1914.* It remains

* Apparently the first suggestion of a Medical History Committee with powers to collect specimens and data was contained in a letter from Lt.-Colonel J. G. Adami to Sir William Osler, instancing the connection between the Army Medical Museum of Washington and the United States Medical History of the Civil War, which was transmitted by the latter to Sir Morley Fletcher of the British Medical Research Committee.

for us to hope that the members of the American and Canadian Section of this Association, which is essentially one of Medical museum experts, may be permitted, individually or collectively, the high privilege of rendering service to our Allied Governments in helping to form worthy collections which will be at once an aid to our medical officers of today, a benefit to those of posterity, and a fitting monument to our noble soldiers who are giving their all in a just cause.

Maude E. Abbott.

THE CIRCULAR MEMORANDUM OF THE BRITISH
MEDICAL HISTORY COMMITTEE FOR THE COL-
LECTION OF WAR SPECIMENS.

The revised Memorandum issued by the British War Office, at the instance of the Medical History Committee, upon the preservation and disposal of War Specimens has reached us through the courtesy of Dr. Arthur Keith, Curator of the Royal College of Surgeons. It is accompanied by a letter addressed to "*The General Officer Commanding Abroad Commands at Home*", and bearing the signature "*M. W. Russell, Surgeon General for the Director General, Army Medical Service*", which requests that the instructions given therein "be brought to the notice of the Officers in Charge of all Military and Territorial Hospitals, and Civil Hospitals admitting Military Patients, in your Command, in order that suitable arrangements may be made for the selection of specimens and their despatch to *The Medical History Committee, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W. C.* Officers should be encouraged to send specimens of the nature mentioned in the annexed Memorandum."

An examination of the Memorandum shows that the directions given therein follow closely the principles laid down in an article on "The Preservation of War Material" by Lt.-Col. J. G. Adami, (A. D. M. S. for the Canadian Forces Abroad,) and E. L. Judah, published in the last number of this Bulletin. We would here draw attention to the further communication by E. L. Judah upon the same subject, on page 21 of this issue, which gives a summary of the technique practicable in War, and supplies a commentary upon such points in the Circular Memorandum as the author considers might be improved upon. This criticism is especially useful in regard to the care of bone specimens. In

the case of moist specimens, Jores fluid as modified by Klotz,* which is the fixation solution given in the Memorandum, and also in the previous article by Adami and Judah, is again recommended by Mr. Judah for routine work in War, but superior permanent results are claimed for the Kaiserling method, which it is stated should be followed under those conditions which admit of the more complicated procedure involved being carried through, as is the case in many Base Hospitals.

The text of the Memorandum follows:

CIRCULAR MEMORANDUM.

WAR OFFICE, LONDON, S. W., 14TH JUNE, 1915.

"A Committee has been constituted under the presidency of Sir Alfred Keogh, K. C. B., Director-General, with a view to the preparation of the Medical History of the War. The task of the Committee requires the active co-operation of Medical Officers attached to all Military Hospitals at home and abroad. This is particularly the case as regards the collection of specimens which illustrate the mode of production, the variety, the pathology, the manner of healing and the results of treatment of wounds and injuries inflicted in the present war. It is hoped that all Medical Officers who have the opportunity will assist the Committee in bringing together the material necessary for a completion of its project.

The Director-General also avails himself of this opportunity of reminding all Military Medical Officers that pathological material from Military Hospitals is the property, not of any individual physician or surgeon, but of the State as represented by the Army Medical Department.

SELECTION OF SPECIMENS

Every specimen which elucidates the manner of production, the diagnosis, the pathology, the treatment of wounds and illnesses incident to war should be forwarded to the Committee.

In the following list some of the specimens more urgently required by the Committee are cited:—

1. *Specimens illustrating the types of wounds produced by the various forms of projectiles used in warfare and the varying effects dependent on range.*

2. *Specimens showing the destruction of tissues along the track of projectiles, the lodgment of foreign bodies, and the deviation of bullets in their passage through the tissues of the body.*

* Klotz & MacLachlan, International Assoc. of Med. Museums, Bulletin No. V, 1915, p. 59. Also Klotz & Coburn, Bull. VI, p. 51.

3. *Specimens illustrating stages and modes in the healing of wounds.*
4. *The results of infection of wounds.*
5. *Specimens illustrating arrest or delay of healing.*
6. *The explosive effects of high velocity missiles.*
7. *The encapsulation of foreign bodies.*
8. *Deformities and defects which result subsequently to the healing of wounds and injuries.*
9. *Specimens illustrating the various forms of fracture of bone produced by projectiles.*
10. *Wounds of blood vessels and the sequelae of such wounds.*
11. *Injuries of nerves and their sequelae.*
12. *Injuries of the spine and of the spinal cord.*
13. *Injuries of the skull and of the brain. The sequelae of such injuries.*
14. *Injuries of the face, jaws, nose, eyes, ear, larynx and structures of the neck.*
15. *Injuries of the thorax, lungs, pleurae and heart. The sequelae which may follow such injuries.*
16. *Injuries of the abdomen and pelvis, and of the abdominal and pelvic viscera. The sequelae of such injuries.*
17. *Injuries of the limbs—particularly of joints.*
18. *Injuries of the uro-genital system.*

PRESERVATION OF SPECIMENS

The fluid recommended for the preservation of specimens is the following:—*

Soda sulphate	20 parts
Soda bicarbonate	20 parts
Soda chloride	20 parts
Pot. nitrate	38 parts
Pot. sulphate	2 parts
Chloral hydrate	100 parts
Formalin	100 parts
Water	3200 parts

Three vessels of convenient shape, each capable of holding about six gallons, are required. Place four gallons of the above solution in each of the three vessels, and label them Nos. 1, 2, and 3. Having washed the blood off the specimen, it is placed for two hours in Vessel No. 1, twelve hours in Vessel No. 2, and twenty-four hours—or, if a large specimen, forty-eight hours—in Vessel No. 3. It is then sufficiently preserved for being packed up and despatched.

* (This is Klotz' modification of Jores' solution.—Ed.)

In the case of hollow viscera, it is necessary to wash out their contents and to stuff their chambers with wet tow or absorbent cotton wool before placing in the first preserving solution. If this is not done such viscera become fixed in a compressed and misshapen form.

DRIED PREPARATIONS*

In certain cases, particularly in fractures of bone and lesions involving the destruction of joints, it may be advisable to make dried preparations. It is recommended that the flesh should be removed, exposing the bones and ligaments, which are dusted over with an antiseptic powder. The specimen is packed up and forwarded for maceration at Museum quarters.

DESPATCH OF SPECIMENS

It is recommended that specimens should be forwarded to headquarters as soon as they are preserved, but, in cases where this is impossible, specimens may be kept in the above fluid for three or four weeks and suffer but little damage.

The following method of forwarding specimens is recommended:—

When removed from the preserving solution, each specimen is surrounded by a layer of cotton-wool or lint which has been soaked in the preservative fluid, and the whole wrapped in an impermeable cover of Jaconet or such like material. The specimen is then packed in a suitable tin or box containing sawdust, tow or absorbent cotton-wool and forwarded by parcels post, or by such other means as may be available. If several specimens are forwarded in the same parcel, they must be packed so as to avoid compression.

HISTORIES AND LABELS

A specimen without a history is without scientific value. Each specimen must be accompanied by a tag or stout label, on which is written the name and age of the patient, his regimental number, the date at which the specimen was first obtained, the hospital from which it was despatched and the Surgeon under whom the patient was treated. Such labels should be securely attached to the wrapping in which the specimen has been placed.* A précis of the history of the case, with a statement of the point or points exhibited by the specimens, should be forwarded at the same time to Museum quarters, preferably under separate cover.

* See the criticism upon this paragraph in the paper by E. L. Judah, page 21.

* (The label should be attached in all cases to the specimen itself. M. E. A.)

ADDRESS TO WHICH SPECIMENS ARE TO BE FORWARDED

The Council of the Royal College of Surgeons of England has placed the store rooms and workrooms attached to the Museum at the disposal of the War Office for the temporary reception, preservation and registering of all specimens connected with the Medical History of the War.

Specimens and parcels should therefore be addressed to:—

MEDICAL HISTORY COMMITTEE,

Royal College of Surgeons of England,

Lincoln's Inn Fields, London, W. C.

All communications relating to specimens already despatched, or enquiries relating to specimens required by the Committee of the Medical History of the War, should be sent to the above address."

Maudc E. Abbott.

Proceedings of the Association

EDITED BY

Maude E. Abbott and Louis Gross
Montreal.

COMMUNICATIONS

Gross and Microscopic Technique

ON THE TECHNIQUE OF THE PRESERVATION OF WAR MATERIAL.

E. L. JUDAH,
McGill University, Montreal.

In the preparation of war material for Medical Museums one of the most important questions is that of transportation both of the specimens and of the fluids required for their fixation. To this end the preservation of natural colour, which is essential whenever the character of the specimen permits, should be carried through as simply and with as few media as possible, while bone specimens should be rapidly dried and sent forward in an easily portable and antiseptic state.

MOIST SPECIMENS.

Moist specimens must be obtained fresh from the autopsy or operation, and not allowed to soak in water for more than a few moments. Only the superfluous blood should be washed away, remembering that the one colour available for preservation, with the exception of the faint colouring matter derived from bile staining, etc., lies in the hemoglobin of the red blood corpuscle, and that this therefore must be preserved. The basis of the methods of colour preservation which are in my judgment to be recommended lies in the chemical change produced by the action of formaldehyde upon the hemoglobin of the red

cell and its subsequent fixation as the red alkaline haematin by the alcohol or chloral hydrate of the solution.*

Two methods may be recommended as available for colour preservation: those of Kaiserling and Klotz-Jores. Of these, where it is necessary to preserve any faint colour not directly due to red blood corpuscles but caused by bile staining or transformation of fats, the Klotz-Jores is the superior; in fact Kaiserling will completely destroy some of the faint yellows desirable to keep in such cases. In all other instances, however, and for general purposes and lasting brilliancy of results I consider the Kaiserling method the best and I think therefore that every effort should be made to use it in routine work where this is possible. But, under war time conditions, the transportation of the various solutions required, and the careful watching needed in the use of the first and second fluids in Kaiserling, renders this method often utterly impracticable in the Field.

For these reasons I would recommend for routine purposes in War the use of Jores' fluid as modified by Klotz. Its advantages under war conditions are the following:—

(1) All the ingredients, with the exception of formalin, can be taken along with the hospital stores in a dry state, as salts, and so are easily transported, and formalin is easily procurable.

(2) Their cost is relatively slight; I know no method of preserving the colours of museum specimens that is of so low a cost.

(3) The use of two fluids only, is necessary.

(4) The length of time in which the specimens may remain in No. 1 is not a matter of care; tissues do not deteriorate by long keeping in No. 1; in fact specimens might be shipped from Europe to America in No. 1, and only after weeks placed in No. 2, and still, after washing well with water, when placed in No. 2 the natural colours show themselves well.

(5) The method is universally applicable for all tissues, with the occasional exception of lung and spleen.

*For full details upon the chemical changes taking place in colour preservation in the methods of Kaiserling and Jores, see:

1. *Kaiserling*—*Berliner Klin. Woch.*, 1896, Bd. 33, P. 775.
2. *Puppe*—*Vierteljahrschrift für gerichtliche Medicin*, 2 Folge XVII, 2.
3. *Abbott*—*American Medicine*, 1903, V, No. 14, p. 541-544.
4. *Jores*—*Verhandlungen Deutschen Pathologischen Gesellschaft* 1913, Bd. 16, p. 357.

THE KLOTZ-JORES METHOD

SOLUTION NO. I.

In his original method Jores recommended the use of commercial Carlsbad salts in his first solution. This has been found however to yield irregular results. Klotz and MacLachlan⁵ therefore substitute an artificial compound which they term "modified Carlsbad salts" of which the composition in 100 parts is as follows:

Soda sulphate	22 grs.
Soda bicarbonate	20 grs.
Soda chloride	18 grs.
Pot. nitrate	38 grs.
Pot. sulphate	2 grs.

This compound they use in the Jores' first solution as follows:—

Modified Carlsbad salts	125 parts
Chloral hydrate	125 parts
Formalin	125 parts
Water	4000 parts

This combination improves on standing for a few days.

Specimens may be left in this fluid for from two to ten days or longer, and are then washed in cold running water for from six to ten hours. All salts and formalin should be thus removed before placing in the preservation fluid (Solution No. II).

Although in using this solution colours in the depth of the organs are preserved almost as well as on the surface, infiltration of organs is fairly slow, and it is therefore always preferable to section these before hardening.

In tropical countries it is advisable to increase the amount of formalin in this No. I solution. At all times a large body of fluid should be used, and the specimen must be changed into different vats containing fresh No. I solution every few days.

As stated above, while the minimum duration of specimens in this No. I solution is from two to ten days, they may be left in it for a relatively indefinite time without much loss of colour. The British Government has taken advantage of this fact, and

⁵ Klotz & MacLachlan—Inter. Assoc. Med. Mus. Bull. V, 1915, p. 59.

has ordered all material to be shipped in this No. 1 solution from France to the Royal College of Surgeons.* It is readily seen that much difficulty in transportation and technique is thus avoided.

SOLUTION NO. II.

In the Klotz-Jores method one of two fluids may be used for final fixation, namely:

- (a) Klotz' modification of Frost's sugar solution.
- (b) Kaiserling No. 3 which is given later in this paper.

Which of these two is to be selected for the final preservative in the specimens preserved by the Klotz-Jores method must depend upon the facilities for getting the cane sugar required for the Frost's solution on the one hand, or the potassium acetate salts and glycerine needed in Kaiserling No. 3 on the other. All things being equal and where ingredients can be obtained, Kaiserling 3 is far preferable to the Frost's solution for permanent preservation on account of the stickiness and poor keeping qualities of the strong sugar extract it contains.

Klotz' modification of Frost's formula is as follows:

Cane sugar	3500 parts
Pot. acetate	160 parts
Chloral hydrate	80 parts
Thynol water	8000 parts

An addition of 20 cc. of dissolved carbolic acid added to 8000 cc. of the No. 2 sugar solution will prevent much of the trouble now caused by molds.

Note.—In Bulletin No. VI of this Association Dr. Klotz recommends a modification of this No. 2 solution which omits the sugar and contains a small percentage of formalin, as follows:

Carlsbad salts	2.5
Chloral hydrate	1.0
Formalin	0.5
Water	100

While sufficient time has not yet elapsed since this article has been published to say whether this solution is altogether satisfactory, yet from my experience I think the formalin will gradually darken the red blood corpuscles, although theoretically its action should be neutralized by the chloral hydrate. The suggestion of it, however, is submitted here as a further alternative which may be experimented with if circumstances should render its use advantageous.)

* See Circular Memorandum, page 15 of this issue.

THE KAISERLING METHOD.

The only disadvantage of this method of colour preservation in war is the high cost of chemicals under present conditions, and the difficulty of transportation. The superior results obtained, however, make it well worthy of consideration.

Most of the unsatisfactory results obtained on this continent have been due to bad technique and an improper percentage in the various solutions. In fact there are about ten different formulae in use with varying results.

After careful comparison of these methods, both in Europe and here, the following process has been found by us to give the best results.

KAISERLING'S SOLUTION NO. I.

Pot. acetate	170 gm.
Pot. nitrate	90 gm.
40% formalin	1600 cc.
Water	8000 cc.

Care should be taken to use only first-class chemicals. Potassium nitrate, Merck's pure powder, and potassium acetate, U. S. P. The formalin should be as free of formic acid as possible.

The length of time the specimen stays in Kaiserling's first fixation fluid has caused a great deal of comment; I consider it of secondary importance to thorough hardening. The specimen should be fixed in such a way that no blood will ooze out when firmly pressed between the fingers. In fact good colour results have been obtained in specimens that have stood from two to four months in the No. 1 solution. This is, of course, in exceptional cases. Intestine should not be left in for more than ten or twelve hours; other specimens of organs from one to five days. But in all instances they must be thoroughly fixed.

Great care must be taken to wash the specimens thoroughly in running water after removal from this solution.

KAISERLING NO. II.

Ninety-five per cent alcohol (ordinary methylated spirits will do) may be used at once without the intermediate stage of 80% alcohol, recommended by Kaiserling. The specimens must be left here until the natural colours, which have disappeared under the action of the formalin in the first solution, return, the

process being watched in the same way as is a photographic plate. The alcohol should not be allowed to go below 80%. To avoid this the specimens should be transferred to a second alcohol of the original strength. The time in which the specimens remain in the alcohol varies according to the character of the particular tissue.

In this stage again the specimens must be carefully washed in water, no traces of the formalin or alcohol used in the first and second solutions being carried on to the final shape. If either the alcohol or the Kaiserling No. 3 solution used smell at all of either formalin or alcohol they must be thrown away. This is absolutely necessary.

KAISERLING NO. III.

Pot. acetate	4 lbs.
Glycerine	2000 to 4000 cc.
Water	10000 cc.

to which 20 cc. carbolic acid may be added as a preservative.

GENERAL TECHNIQUE OF COLOUR PRESERVATION.

There is nothing as important in the preparation of wet pathological specimens as that they should be properly laid out and held in correct anatomical relation, immediately after obtaining them from autopsy or operation.

Tanks for preparing the specimens may easily be found by taking a wine cask, three feet or more in length, and sawing it in two, and making wooden covers to cover over the top of each half. A layer of sacking or cotton cloth may be fastened on the under surface of the covers, to make them more air tight. There must be no nails coming through the cask, in fact no metal must be allowed to come in contact with the specimen at any time; glass pins or cotton thread are quite sufficient to hold them in place.

When it is necessary to put a specimen on the stretch, rough glass frames are the best. When, however, cardboard or wood have to be used they should be first wrapped with wet absorbent cotton. No dry cotton wool should come in contact with the specimen at any time as it is almost impossible to remove later.

Cheese cloth, paper, or other tissue is inadvisable as it marks and spoils the specimen.

Remember that with either the Klotz or the Kaiserling method material has to be thoroughly hardened before putting into

the final fluid. In fact it is better to overfix and lose a certain amount of colour, than to underharden the specimen. Much fading in colour preservation is due to this cause. Specimens also go bad and cause a fungus growth in their jars.

When a specimen is found to have gone mouldy it must be run through the No. 1 solution in either Kaiserling or Klotz in the same way as fresh material. In going over a lot of jars a single infected one will often infect several others through the hands. Great care should therefore be experienced when an infected specimen is found not to pass on the contamination. Nothing but distilled or boiled water should be used in making up the final solution.

When specimens have been left in spirits for too long a time much colour can be restored by leaving them in equal parts of Kaiserling No. 3 and glycerine for 24 hours, allowing for the amount of glycerine already in your Kaiserling fluid.

Klotz-Jores specimens may be permanently preserved in Kaiserling No. 3 with excellent results, as Kaiserling specimens after being put through No. 1 and 2 may be preserved in Klotz-Jores' No. 2.

In some museums a mixture of equal parts of glycerine and water (which is the old Jores No. 3) is substituted for Kaiserling's No. 3 solution, which contains potassium acetate. In my judgment this is a mistake as the potassium acetate is an essential constituent in preventing dissolution of red cells. In my experience it is impossible to use more than about 28% of glycerine, and even this amount tends to make lung and spleen specimens very dark or transparent; other organs are sometimes affected in the same way. As low a percentage as 16% can be used with very good results.

FORMALIN.

Formalin (that is, a 40% solution of Formaldehyde), to which we owe all our modern advances in colour preservation, is a most valuable preservative and may be used alone, when it is impossible to get the different salts required in the first solutions of Kaiserling or Klotz-Jores. It may be used for all specimens which do not require colour preservation in a 2% solution (of formaldehyde). Where colour preservation is desired a solution of a strength of not less than 6% formaldehyde must be used. The specimens may be transferred from this to alcohols and thence to the final preservative just as in the last stage of the Kaiserling method.

DRIED SPECIMENS.

Methods of the preparation of *bone specimens* are very similar to those used for osteological natural history material. After removing all superfluous flesh, being careful of the capsular ligaments, soak in several changes of water for one or two days to remove as much blood as possible, taking care that the specimen does not macerate or any small portions of bone drop out. Then place in a saturated solution of arsenic (arsenic trioxide) from ten to fifteen minutes, and allow it to dry thoroughly in the air; pack in paper or any kind of cloth so that the specimen will not be knocked around in transit.

Arsenical soap may also be used when desired in place of the arsenic solution; apply it with a paint brush.

This method will allow of easy maceration afterwards and also preserve the capsular ligaments when so desired.⁶

The sprinkling of an antiseptic powder over specimens is not satisfactory as they quite frequently go bad and become very disagreeable, besides many of the powders used for this work contain corrosive sublimate which is dangerous to those working later with the material. Dry arsenic is not so readily absorbed by the specimen as when in a saturated solution.

In making up a saturated solution of arsenic the arsenic should be placed in cold or luke warm water and then boiled for fifteen or twenty minutes. By adding one-twelfth of alcohol to this solution it will keep indefinitely and make an excellent preservative for wet pathological specimens where it is not necessary to preserve their colour. It is known as Sappey's Fluid.

PACKING OF SPECIMENS.

Barrels can be employed for transportation; loosen the upper hoops at one end, remove the end; divide the interior into compartments by means of slats somewhat as an egg crate, giving each specimen a compartment to itself, and in this way build up the contents from the bottom. Wrap each specimen in wet absorbent cotton. When the barrel is full replace the end, and the metal hoops, drive them home tight, and fill with fluid through the bung.

⁶ *Judah-Bull. Inter. Assoc. Med. Mus.*, No. V, June 1, 1915, p. 90.

Hermetically sealed tin cans are also very good when it is possible to get them. Care must be taken, however, not to allow the specimen to come in contact with the tin especially if there is any formalin in your preserving fluid.

TAGS OR LABELS.

Equal in importance to the specimen itself is the reference number which must be attached to each one, which gives the clue to the clinical history and notes upon the case. This tagging or blocking should be done at the autopsy or operation and the label should always be attached to the specimen itself and not to the wrapper.*

Owing to the various fluids the specimen has to go through in course of preparation metal tags which rust and disfigure the specimen, celluloid which dissolves in alcohol, and pencil writing on cardboard, which becomes obliterated and torn off, should all be avoided. The following devices may be substituted:

(a) Consecutive numbers stamped by means of a Bates automatic numbering machine on a length of white tape one inch wide, which is then boiled in paraffin and rolled on a stick, the number next in order being cut off and attached to the specimen as required,[†] or (b) Strips of parchment perforated with a cheque stamping machine, is also most excellent.

When impossible to get a numbering or a stamping machine waterproof ink on strips of cotton may be used.

I wish to thank Dr. M. E. Abbott for much assistance rendered.

* Compare *British Circular Memorandum*, page 15 of this Bulletin.

[†] Judah—Intern. Assoc. Med. Museums, Bulletin No. IV, p. 45.

AN AMERICAN SUBSTITUTE FOR RUSSIAN PARAFFIN.*

ALDRED SCOTT WARTHIN,

Ann Arbor.

In Schnorl's laboratory in Dresden, in 1899, I first became acquainted with a variety of paraffin said to be made in Russia. This paraffin had such characteristics as to make it superior to all others for the infiltration and imbedding of tissue. It had a bluish translucency, a clear ring when the cake was dropped upon the table, and gave an unbroken section, even at 2-3 microns, owing to its unusual waxy consistency. Melting-point, 52°C. Up to the period of the War we have used this paraffin exclusively, obtaining it from Kahlbaum, at a price, however, varying from 25-50 cents per pound. After using up our store, efforts were made to obtain a good paraffin elsewhere. All other available paraffins were tried out, but all of them, foreign, American, Standard Oil, parawax, etc., seemed much inferior. They were all more crumbling and gave inferior sections, and ribbons. The matter was taken up with the Standard Oil Company. After some experimentation their laboratory at Bayonne, New Jersey, furnished us with a number of samples, one of which, Sample C, seemed to us as good as the German-Russian product. We have accordingly stocked our laboratory with this paraffin and find it thoroughly satisfactory. It is also much cheaper than the other. Unfortunately since the meeting in New York we have been informed that owing to government demands the Laboratory would be unable to furnish us with any more of this paraffin.

* Presented at the Meeting of the International Association of Medical Museums, New York, April 5th, 1917.

HISTOLOID AS AN IMBEDDING AGENT.

WILLIAM M. JOHNSON.

(*Technician to the Pathological Laboratory, Bellevue Hospital, N. Y. City. Dr. Douglas Symmers, Acting Director.*)

It appears that a number of laboratories have deemed it expedient to resort to paraffin under the impression that there is no acceptable substitute for the imported celloidin. In the Pathological Laboratories at Bellevue Hospital we have been making use, for a number of months, of an American product known as Histoloid which is prepared by the Celluloid Company, of New York, which is described as a specially prepared pyroxylin. It answers every purpose of the pyroxylin made in Germany under the name of celloidin.

The method that I am using at Bellevue Hospital follows:

Tissues are fixed in formalin, placed in 95% alcohol for 24 hours then in equal parts of acetone over copper sulphate in a wide mouth bottle, for 24 hours, or for 12 hours if haste is imperative. The sections are now transferred to oil of cloves until clear; this usually requires only 2 or 3 hours. They are then placed in Histoloid, which is prepared in this fashion:

Two hundred forty grams of Histoloid are washed in running water for about three days, dried, and then dissolved in 1100 cc. each of chemically pure ether and Squibb's absolute alcohol. As a rule three days suffice for solution, the receptacle being well shaken from time to time. Sections are kept in the Histoloid solution for 24 hours, or longer, then mounted and hardened in chloroform, and cut 2 or 3 hours later.

In a word, Histoloid is made to take the place of celloidin in the so-called rapid celloidin process, and the substitution, we have found works admirably.

Sections may be cut from 7 to 10 microns in thickness.

Editorial Note:—The Pathological Laboratory of the University of Michigan has tried out Bioloid, Parlodion, and Purified Pyroxylin (Malinckrodt) and found them to be practically identical and as good as the Schering Granular Celloidin.

A MODIFIED SUGAR SOLUTION AS A FINAL PRESERVATIVE FOR MUSEUM SPECIMENS.*

E. B. ELLIS,

Hôpital Français, New York.

The Kaiserling No. 2 Solution so long in use as a final mounting of Museum specimens has been of late extensively, if not entirely, replaced by various modifications of this fluid and by some original efforts along this line of preparation.

Where many museum specimens are desired for teaching purposes in schools and hospitals, the cost of such a preparation has heretofore been quite an item of expense to the laboratory. We have attempted to perfect such a medium as would combine economy with efficacy.

This method embraces the usual stages of fixation, colour restoration and final preservation, and has proven entirely satisfactory, in that it invariably preserves the colour of specimens, does not alter the staining characteristics and is economical as compared to the original Kaiserling Solution.

1. Specimens brought fresh from autopsy or operating room are washed slightly in running water to remove debris and are placed immediately in a solution of 10% formalin to which has been added a little common salt.

2. We next used waste alcohol which had not been discoloured, to bring the colour back to the specimens, and the time in this stage varied from about two to six hours, or until colour is sharp. We allow specimens from this to drain a little before placing them in the final preservative which is made up according to the following formula:

3. (For 5 litres). Dissolve 5 lbs. granulated sugar in 2 litres warm water. Dissolve 1 lb. sodium acetate in 1 litre of warm water. Dissolve $\frac{1}{2}$ gram thymol in 1 litre warm water and add 1 litre 0.5% formalin. Mix and filter when cool.

This fluid is especially adaptable for museum specimens which are to be sealed and not exposed to much handling, though we have a stock crock of this solution in which we keep many gross specimens in natural colour. These bear a tag which is made of plain cloth on which the identification number is written in India ink.

* Presented at the meeting of the International Association of Medical Museums, New York, April 5th, 1917.

Aside from the sticky nature of this solution, which might readily be washed free in running water without apparent injury to the specimens, it has no other disagreeable feature.

We experimented with this fluid in the laboratory of Cornell University Medical College in 1913, and there are many specimens of the original fluid. Further, this fluid has preserved the colour of our specimens in the laboratory of the French Hospital so successfully, and at so low a cost, that we feel justified in offering this suggestion of its use to those who are interested in an economical, yet effective medium for the preservation of museum specimens.

ON THE METHODS OF ORGAN RECONSTRUCTION BY INJECTION OF THE ARTERIAL TREE.*

LOUIS GROSS, M.D.,

Douglas Fellow in Pathology—McGill University.

From the Laboratories of McGill University and the Royal Victoria Hospital. Prof. Horst Oertel.

Last summer, at the suggestion of Prof. Horst Oertel, I undertook the study of the arterial architecture in chronic productive nephritis. It was in endeavoring to improvise a technique which might give a clear and plastic demonstration of the arterial tree, that we came to use the method which is described below.†

We began our studies by the well-known colored gelatine injections with subsequent serial sectioning, and used at first almost entirely carmine gelatine made up as follows:—

Allow 100 gms. of gelatin to soak two hours in 200 cc. of distilled water. Warm until the gelatin dissolves and filter through a flannel. It is advisable to place the filter in an incubator to prevent the jelly from setting while filtering.

Dissolve 15 gms. of aqueous soluble carmine in 300 cc. of distilled water. Add 1½ drms. of ammonia. Filter.

Now mix the filtrate with the filtered jelly. Add about 1 drm. of acetic acid to the mixture.

* Presented at the meeting of the International Association of Medical Museums, New York, April 5th, 1917.

† A detailed account of the incidental anatomical and pathological findings by this method with full illustrations, is published by the writer in the *Journal of Medical Research*, Vol. XXVI, No. 3, 1917.

We found that this jelly flowed well and did not diffuse into the tissues.

A blue jelly made by using Prussian blue instead of carmine, did not give as satisfactory results as the red. Here the ammonia with subsequent neutralization is unnecessary.

The apparatus which we used is very simple of construction and has proven quite satisfactory.

It consists of a wooden box lined with copper. Separating it into two chambers (upper and lower) is a pan which has an out-flow tube connecting it to the outside. In the centre of the pan are four openings. These openings are necked to prevent any dripping into the lower chamber.

The whole apparatus is kept at a temperature of between 45° and 50°C. by an immersible electric heater, which also serves the useful purpose of keeping moist the organ which is being injected. An electric light enables us to keep watch of our solutions, and also tends to equalize the temperature in the chamber.

Outside of the incubator is a Wolff's flask, the air of which has been compressed by water pressure, or better still forced in from a compressed air tank to a pressure of 200 mm. of mercury, which is registered by a manometer. The pressure tube from this bottle is now connected to the pressure tube of a saline flask which is also kept outside of the chamber, so that it can be easily refilled without necessitating opening the doors of the incubator, thus allowing a variation in temperature.

The saline is then forced out of this bottle through a tube into a saline bottle within the incubator; it is here warmed and passes by a tube into the kidney which lies in the upper chamber. A continuous flow of saline is thus kept up until the washings from the kidney are clear of blood pigment.

It is said that the smooth muscle of the arterial walls is irritable and contracts under stimulation even forty-eight hours after death. On this assumption, since it is our endeavor to obtain wide and permeable channels for our injection fluid, we now allow about 100 cc. of a 10% solution of potassium sulpho-cyanide to flow slowly through the kidney, with the object of rendering flaccid the vessel walls.

This is followed by another irrigation with saline and, we have noted, that these second washings usually appear bloody again, probably indicating that new channels have become permeable or that old ones have become more permeable.

After the kidney has become clean, the pressure tube is disconnected from the saline bottle, and connected to that of the

gelatin bottle, the outflow tube of which is in turn inserted into the kidney.

Injection is continued until a volume of gelatin approximately equal to that of the kidney has passed out of its vein. After this tie off all the vessels at the hilus—wash the kidney in cold water, and immerse it in 10% formalin for 48 hours.

Upon sectioning, we usually find the injection has been complete, the gelatin having found its way evenly and thoroughly into all the capillaries beyond the glomeruli.

While passing a section of such a kidney through xyloï after dehydration, it was noticed that the coloured injected vessels stood out in marked contrast to the cleared parenchyma. This suggested to us the idea of seeking a method that might do away with the tedious and often faulty serial section and reconstruction technique. Xyloï we found inefficient because it was applicable only to thin sections, and because the sections soon became opaque.

After trying out several other fluids we found that aniline oil gave very good results. Sections even 5 mm. in thickness could be cleared fairly well and showed up the blood vessels in fair detail. But even this method gave rise to the possibilities of error which sectioning and reconstruction are exposed to; our aim was to be able to see the arterial tree without mechanically disturbing the kidney.

This we finally succeeded in doing, by using a gelatin which is made up as follows:

Add 100 gms. of gelatin to 200 cc. of distilled water, soak, dissolve and filter as outlined above.

Mix this with 300 cc. of fine barium sulphate (such as is used for barium meals). The barium should have the consistency of heavy cream.

By injecting the kidney with this mass we could, without sectioning, obtain skiagraphs of the intact kidney, which showed in undisturbed detail the arterial tree up to and including the glomerular branches. By taking stereoscopic plates we can obtain a plastic visual conception of the whole arterial architecture.

The writer wishes here to express his indebtedness to Prof. Horst Oertel for his aid and advice throughout this work.

Note: Since writing this article we have found in the literature that several modifications of this last method have already been used—thus, *Sampson*, in *Surg., Gyn. and Obstet.*, Vol. 14, 1912, used a bismuth subnitrate suspension in gelatin and obtained very good results. Barium,

however, besides being very much cheaper, comes in finer crystals hence makes a less viscid suspension—one that will flow through the very finest vessels. Our apparatus too, does away with most of the difficulties of gelatin injections.

Beck, in Surg., Gyn. and Obstet., Vol. 12, 1911, shows a beautiful injection with a bismuth subnitrate suspension in vaseline. Here the additional objections to the bismuth are that injection of the paste must be carried on by means of a syringe, hence accurate estimate of temperature and pressure, such as is necessary in delicate injections, cannot be ascertained. Section of the organ destroys the injection, and it is difficult to preserve permanently even the intact organ. As to the difficulty in technique Beck says on page 7, "The technique in producing perfect results in these anatomical studies, requires considerable experience, and many failures must precede the attainment of perfect results." By our method excellent results can be obtained from the first injection.

METHODS OF MOUNTING ANIMAL PARASITES IN SOLUTION, INCLUDING THE USE OF PLASTER OF PARIS.*

FRED D. WEIDMAN, M.D.

(From the McManes Laboratory of Pathology of the Medical School of the University of Pennsylvania, Philadelphia, Pennsylvania.)

Most of the animal parasites in our collection, which now numbers just short of one hundred and fifty, were mounted seven years ago by Dr. Allen J. Smith. At that time the larger specimens were suspended from glass frames or wound around or tied to plates of glass in the manner familiar to everyone, and which makes thoroughly presentable mounts, while those that were small enough were fastened to glass slides with hot gelatin. It is with these smaller specimens that most of us have trouble, and with which this communication is especially concerned.

In 1910 we imported twenty-two specimens from Vienna mounted in a fluid medium and attached to glass by what appears to be gelatin. On reviewing these to-day, only one shows some discolouration of the gelatin and none have loosened. This is most creditable, for they have been handled in student demonstrations and shipped by express to at least two exhibitions. We

* Presented before the meeting of the American Section of the International Association of Medical Museums, New York, April 5th, 1917.

have not obtained anything like such good results in our attempts to imitate the Viennese, and evidently they practice some little trick of which we are not aware.

Dr. Smith (Allen J.) analyzed the Vienna mounting medium and found that it consisted of two parts of acetone (we use commercial) and three parts of a 5% formaldehyde solution. This

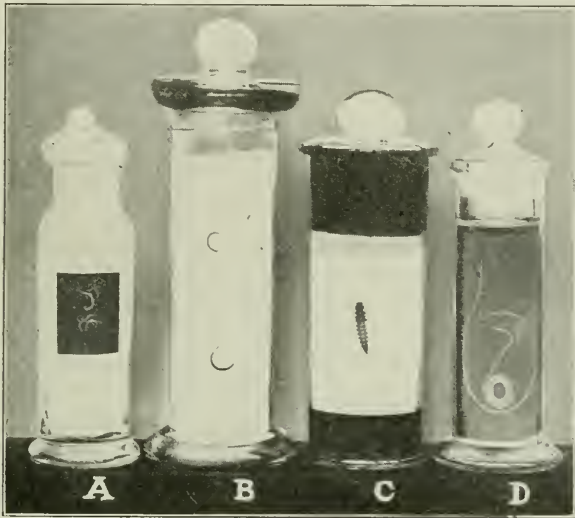


FIG. 1.—HERMETICALLY SEALED EVAPORATION-PROOF JARS FOR SMALL SPECIMENS. NATURAL SIZE.

Parasitic worms mounted against plaster-of-Paris background: *A*, hookworms shown against a black paper "window," which in turn is supported by a plaster-of-Paris backing. Shows use of necked container. *B*, whipworms mounted against plaster-of-Paris backing. *C*, insect larva mounted in depression. Passe-partout tape wound around container above and below, to give finished appearance. *D*, filariae mounted against black paper background, in turn supported by plaster backing.

is far superior to the usual simple formaldehyde solution, Dr. Smith finding that it made the gelatin less visible, and that the specimens loosened much less frequently. But even with this the gelatin method has not been altogether satisfactory, for on reviewing a collection of twenty-nine parasites thus mounted I find that fourteen have loosened, and that the gelatin has become dis-

coloured in several, evidently from materials dissolved from the parasite.

I began experimenting with different methods two years ago, all to the end that the specimen should be first brought as close to the face of the container as possible in order to modify the effects of a possibly cloudy medium, and, secondly, if the specimen permit, held in position by pressure against the face by a presentable backing.

This is accomplished for larger worms like ascarids by holding them close to the face by sheets of coloured celluloid (black, blue, or white, depending upon the colour of the worm), behind which cotton is packed to give the proper pressure. This is the best plan in round jars, where the backing must be curved. Black photographic paper is a fair substitute for cotton, but, being so yielding, becomes uneven from the uneven pressures. With rectangular containers coloured glass plates are best. The worms are held in position by pressure in all of these methods, the pressure being lightest where the parasite fits the container snugly and one end rests on the bottom. In the case of smaller worms like uncinaria, the glass and celluloid backings will not serve, because they cannot be adapted nicely enough to the uneven interiors, and then the parasite will not always be properly gripped, and may fall out of position. A paper backing will serve here, either black or white, but a finer appearance is produced if a plaster of Paris is used.

This is made by filling the (cylindrical) container one-third full of plaster of Paris cream, stoppering it and laying it on its face to harden. It is then loosened and the worm adjusted between it and the face, after which cotton is packed behind it until the specimen is held firmly in position. If a black background is desired a square piece of black paper is first placed upon the white background and the parasite then adjusted upon the paper.

Workers in plaster are frequently bothered by the formation of bubbles, which leave a pitted surface on hardening. These form during the mixing of the plaster, which should never be stirred vigorously. In mixing, the plaster should be sprinkled on the surface of the water, never adding so much that the surface becomes dry. Never pour water into the plaster. Allow the plaster to settle for about five minutes, when the layer of water on the surface is poured off. Now stir very gently and without introducing air. Prepared in this way it is of the proper con-

sistency for pouring and free from lumps and bubbles. The plaster has not appreciably softened or discoloured in two years in a 2% formaldehyde medium, but suffers in both of these respects in Kaiserling.*

Within the last two years I have mounted some very small worms in hermetically sealed glass tubes. A piece of ordinary 6 mm. glass tubing about 6 or 7 cm. long is sealed at one end. When cooled it is filled about half full of formaldehyde solution (2%) and a segment of closely fitting glass rod 2 cm. long dropped in. The parasite is then added and the upper end sealed quickly by the blowpipe. It is then mounted in a wooden base, and the upper end (and lower if desired) wound with label or passepartout tape to give a finished appearance and hide the air space above. With this method the parasite may be examined from all sides with the loupe and with a minimum of mounting medium material between it and the eye. Thus far none of these tubes has broken at the end when sealed, owing probably to their small size, for larger ones which were used to hold larger specimens have generally cracked. That this is a possible method is proved by the fact that glass workers seal surgical ligatures thus, and make the tubes we see in carpenters' levels and household barometers.

A TEACHING COLLECTION CONNECTED WITH THE
DEPARTMENT OF SURGICAL PATHOLOGY,
HARVARD MEDICAL SCHOOL.†

DIANA P. BLAIR,

Through the courtesy of Dr. E. H. Nichols.

Starting as a few yearly exercises in the process of inflammation and repair as related to surgery, and aided by a small private collection of pathological specimens, this department made an humble beginning in 1897. In 1901, the work received recognition as a department, and was allowed a laboratory unit in which to carry out experimental investigation of surgery as correlated with disease. The unit consisted of two working rooms

* For full details on the subject of plaster backings see *Weidman*, Jour. Amer. Med. Assoc., Nov. 6, 1915, Vol. XLV, pp. 1634-37.

† Received for publication June 7th, 1917.

for the instructor and his assistant, a laboratory, a small animal operating room, and a room for the artist. In 1913, the quarters having been for some time quite inadequate, the school provided another group of rooms, with much more space and better equipment.

The department now has a room for the instructor and secretary, an exhibition room with store room attached, a laboratory for technical work, and a large experimental operating room. Here in groups of six men per month, the fourth year students take an elective course in surgical pathology. Each group in its allotted time, with a definite problem in mind, operates upon a series of animals. They watch the progress of each case and note the microscopic findings of the tissues which they have cut and stained.

In starting the collection for the department, there was first prepared from experimental and clinical material, a series of microscopic sections which would tell the histological story of disease and its repair. Not only were these sections to be interpreted by the microscope, but photographed and enlarged, they could be thrown upon the lantern screen, or, as pictures, studied at first hand. Furthermore, the sections were, under the direction of the instructor, interpreted and drawn by the artist. Sometimes they were reproduced literally, but more often conventionalized and made diagrammatic, that their elements might be more easily understood. There are now nine thousand of these slides, one hundred slides of each section. These sections are kept on trays in pasteboard boxes, a complete series in each box.

At the same time, from every available source has been gathered pathological material of soft tissue and bone, to supplement the teaching at the hospital clinics and to illustrate the lectures. Every effort is made to keep this collection up to date and illustrative of the pathological conditions that the men are studying. There are seldom more than five hundred specimens in use. For example, for a demonstration on the appendix, there are six regular samples of appendicitis,—acute, subacute, chronic, tuberculous, gangrenous, and cancerous, besides a few spectacular cases showing a strayed gall-stone or the classical grape-seed.

These specimens are used during the regular second year course in surgical pathology. The exhibit is made to correspond with each day's teaching. Fortunately, the exhibition room adjoins the amphitheatre, making it easy for the men to pass through en route to their class rooms. Upon a specially planned



FIG. 1.—ARRANGEMENT OF GROSS SPECIMENS TO ILLUSTRATE LECTURE IN SURGICAL PATHOLOGY.



FIG. 2.—ARRANGEMENT OF PHOTOGRAPHS, DRAWINGS, X-RAY POSITIVES, HALF-TONES, PAINTINGS OF GROSS SPECIMENS AND OF THE CLINICAL ASPECTS OF CASES, DIAGRAMMATIC DRAWINGS OF OPERATIVE PROCEDURES, ETC., TO ILLUSTRATE LECTURES IN SURGICAL PATHOLOGY.



FIG. 3.—METHOD OF STORING PHOTOGRAPHS, X-RAY POSITIVES, MICRO-
PHOTOGRAPHS, ETC.



FIG. 4.—EXAMPLE OF COMBINATION OF PHOTOGRAPH OF CLINICAL FEATURES OF CASE AND X-RAY POSITIVE. CASE OF CHONDRO-SARCOMA OF ULNA IN BOY OF FIFTEEN YEARS.

museum table in the centre of the room are arranged the gross specimens illustrating the subject of the lecture. This table is strongly built, eight feet by four feet, with two open shelves above, measuring six feet four inches by one foot eight inches, the table proper supporting the heavy jars and the shelves being used for the smaller ones. About fifty jars of varying sizes can be displayed if necessary.

Also upon the walls are shown pictures of the same subject. These pictures, of which there are now one thousand, constitute what is, perhaps, the unique part of the department's teaching resources. The making of them has covered a period of twenty years. Beginning with the first lessons in repair, each subject taught is illustrated by a series of pictures. Photographs and drawings of microscopic sections, X-ray positives, half tones and diagrammatic drawings of operative procedure, paintings of gross specimens and of the clinical aspect of cases. As many as possible are in color. Wherever possible the human aspect is emphasized, making them a valuable supplement to the hospital clinic. Also every thing that pertains to a case is procured, that the student may study it from many view points. For instance, in a case of osteo-sarcoma, there is the clinical portrait and X-ray before operation, and a painting of the gross specimen and the photomicrograph. This makes a complete demonstration of the case.

These pictures are mounted upon brown and gray cardboards with a legend slip attached giving the data of the case. They are framed in two uniform sizes, 8 in. by 10 in., and 10 in. by 14 in., with narrow black mouldings. When not in use, they are stored in a dark room, upon shelves, their catalogue number showing on the edge of the frame. All specimens, pictures, lantern slides, etc., have the same serial number where the cases correspond. For example, osteomyelitis is always VII. Where the catalogue card reads VII-39.3.39., it means that in the osteomyelitis exhibit is a picture 39, a gross specimen of the same case numbered 3, and a lantern slide of the pictures duplicating its number 39.

This is, as has been said, purely a teaching collection, limited in size and to a special subject, surgical pathology.

THE SOUCHON MUSEUM OF NORMAL ANATOMY.*

BY EDMOND SOUCHON, M.D.,

*Professor Emeritus of Anatomy and Curator of Museum,
Tulane University, New Orleans, La.*

[*Editorial Note.* Dr. Souchon's osteological preparations are said to be especially fine, and his method of preparation to show the natural color of muscles with their full dissection is of much value.]

A STUDY MUSEUM.

By resolution of the Board of Administrators of the Tulane Educational Fund, the Museum of Anatomy of the School of Medicine of Tulane University was named the SOUCHON MUSEUM OF ANATOMY.

It is purely a museum of *normal anatomy*. It occupies in the New Richardson Memorial on Tulane Campus, a large room 85 x 36 feet, flooded with light through numerous windows and skylights. A notable and unique feature is that it contains no cases against the walls or otherwise, but only rows of tables on which the preparations stand in large glass jars (36 inches by 7½, 24 inches by 11½, and 24 by 7½), so that the students can come directly to them and study them for themselves. Moreover there are in the museum no papier maché, no wax models, no dried specimens. It is composed exclusively of the "real things", of dissections made after the new method† elaborated by the writer, with the liberal financial aid and the encouragement of Tulane. It is essentially a modern *Study Museum* in the fullest meaning of the words.

The Museum possesses sixty-seven large glass jars with preparations on Osteology, forming the most complete collection known to the writer, with the exception of that at Harvard. Next come three hundred and fifty large glass jars containing actual dissections, with permanent color of muscles, vessels and organs. No such preparations of normal anatomy with permanent color exist in any other college in the United States, or in Europe, so far as we could ascertain in our travels.

* Presented at the Meeting of the International Association of Medical Museums, New York, April 5th, 1917.

† This method was published by the writer in the *Anatomical Record* of November, 1914, and March, 1917.

Each structure in each specimen bears a number, and on an appended card is the name of the structure opposite the number.

The great advantages of this modern study museum are to prepare the students for the dissections, and to show them the great number of things which they do not and cannot dissect in an ordinary dissecting room course. It enables them to review rapidly and it affords former students the opportunity to rapidly "relearn" much anatomy. The preparations can be taken into the dissection room and guide the students in their dissecting.

The thorough usefulness of the Museum, however, will not be fully brought out unless two or three hours a week are allotted on the lecture card to the study of the preparations by the students, and until they are impressed with the fact that a quiz on these preparations will be a part of their examination on anatomy.

Of the three hundred and fifty dissections there are about one hundred and fifty which students do not see in the dissection room. They are marked with a red spot. These at least should be studied by the students.

ANTHRACOSIS ASSOCIATED WITH CHRONIC TUBERCULOSIS.*

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In a previous communication we have reported our observations upon the deposit of carbon in the lung as it occurs in community life of the present time. In that study we were chiefly interested in the presence of anthracosis as it is found in every individual and in the manner of distribution of the carbon pigment to different portions of the lung structure. It was found that carbon is readily taken up by the tissue of the normal respiratory system and that it finds lodgment in particular areas with fair uniformity. The pulmonary deposits of carbon vary in their extent in direct proportion to the carbon content of the air, so that individuals of a given community have a fairly uniform amount of deposit in the lungs. By actual analysis these amounts of carbon were found to vary from 1.5 to 5.3 grams for each lung in individuals residing in the Pittsburgh district. On the other hand

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the lungs of individuals from non-industrial communities were found to have a content well under one gram for each lung. These figures give a fair estimate of the difference in the quantity of carbon contained in the air of communities varying widely in their business activities.

On the other hand the actual amount of carbon deposit in the lung tissue must not be too freely accepted as an indication of the quantity of the smoke pollution of the air in that it can be readily demonstrated that in a given community the permanent residents do not show a constant amount in their tissues. Thus as we have previously pointed out, a considerable variation is observed in the regional distribution and in the actual amount of carbon contained in particular areas of lung, and this is in direct proportion to the presence of certain pathological changes. Under certain conditions carbon is prevented from localizing in particular pulmonary areas due to the mechanical effects of massage during respiration. This was particularly noted in the lung tissue which during breathing was repeatedly pressed upon by the firm rib structures. In emphysema the mechanical pressure of the ribs upon the soft lung becomes still more evident. Under these conditions the rib grooves in the lung are almost devoid of carbon. The opposite to this condition, that is, the unusual accumulation of pigment in particular areas, has also been repeatedly noted. Areas of chronic inflammation are particularly prone to have a greater carbon deposit in their vicinity than in the remaining lung structures. Although this is broadly true, an analysis of the type of chronic inflammation must be made to appreciate the association of anthracosis with the pulmonary lesion. As an example we would point out that ordinary fibrous bands of pleural adhesions which represent the late stage of an inflammatory process rarely show a carbon deposit equal to that present in other portions of the lung. The history of these adhesions usually indicates a primary acute process during which polymorphonuclear leucocytes have played the most important part as phagocytic cells. Then the process of repair is accomplished by rapid organization in which fibroblasts and new capillaries constitute the most active tissues in the lesion. It is true that in a process of organization, a certain number of endothelial cells, the phagocytes of foreign inert materials, are to some extent present and active. Yet their numbers and the length of time of their stay are insufficient to bring about any great change in the carbon content of the tissue under repair. It is this wandering endothelial

cell to which we will revert our attention in subsequently dealing with the process of anthracosis when associated with tuberculosis. The majority of pleural adhesions have but little effect upon the lung tissue lying proximal to them. The exuberant fibrosis has its origin from and is attached to the pleural layer, in which it tends to obliterate the lymphatic channels so abundant in these parts. It is possible that the localized fibrosis of the pleural tissues lessens the free migration of cells in the lymphatic channels, and thus diminishes the quantity of carbon that is normally transported in these structures.

Under the conditions, however, of chronic inflammation in which particular types of cells play a part in the process of reaction, the opposite may be the effect. This is strikingly true in chronic tuberculosis and probably also true in the more acute types.

A word about the mechanics of carbon transportation is here necessary to obtain a proper understanding of its bearing upon the problem of tuberculosis. The fate of the carbon particle lying within the bronchioles and pulmonary alveoli, its phagocytosis by particular endothelial cells and its transport along lymphatic systems have been demonstrated in the work of Haythorn. He was able to show that the same type of cell, of endothelial character, which can migrate into the air sacs and phagocyte tubercle bacilli, is also capable of and most active in phagocytizing carbon from the same locations and can carry their load into the alveolar walls of the lung and wander to favorable or unfavorable situations in the lymphatic system. The migration of carbon is mainly, if not entirely, carried on by phagocytic cells. There is no longer contention that foreign material of its own initiative enters tissue to be deposited in regions of its own selection. The amount of carbon which is taken up by phagocytic cells is alone determined by the amount which is available in the regions where phagocytosis is carried on. The phagocytes of the lung can and do deal with a most variable quantity of carbon, the amount at times with miners being enormous. The early evidences of carbon deposit are easily followed in young children or in small animals. The first appearance in the lymph nodes about the bronchi and blood vessels as well as the occasional streaking of pigment along lymphatic channels of the pleura is easily demonstrated. Gradually the quantities in the lymphatic systems increase until the large lymph nodes are blackened, the pleural channels are delineated and the nodal points of convergence of

several lymph tracts are clogged with the accumulated carbon-bearing phagocytes. During the early periods the carbon is all contained within cells.

A carbon deposit is found to a greater or less degree in all individuals and, because a certain grade of anthracosis has been found compatible with a healthy state of the respiratory organs, it has been repeatedly urged that carbon has no appreciable effect when lodged in tissues. This is true only when the quantity deposited has not led to secondary reactions. It has become apparent, however, that when the amount of carbon within the tissues has increased beyond a certain degree, definite tissue changes will result. While in the early stages the foreign material remains as an intracellular substance of the endothelial phagocytes, it is found that the dense aggregation of these cells within lymph nodes, channels or interstitial spaces leads to the death of some of these cells with the liberation of their contents. In the event that the available phagocytes are themselves overloaded with carbon, the free foreign material may lie for some little time as an extracellular substance and mildly irritate the surrounding tissues. The phagocytized carbon when enclosed within the cytoplasm of cells does not appear to have any irritating effect upon neighboring cells, but when a quantity of it becomes free and in contact with connective tissue, it appears to stimulate growth of these structures. Thus, with the larger quantities of available carbon, there is bound to be more of it which is uncared for by the phagocytic cells and which has an opportunity of acting as a mild irritant. It is only after the lapse of a considerable time that these larger anthracotic masses show a response in the fibrous tissue about them. At times the connective tissue proliferation becomes quite marked so as to encapsulate the deposit, or a diffuse fibrosis is found to permeate the structure in which the carbon has accumulated. These areas of fibrosis are very variable in their extent, sometimes leading to diffuse thickenings of the lung alveoli or forming small nodular masses which with the inert content simulate concretions.

The influence of contemporary processes upon the distribution of carbon in the lung is well illustrated in chronic localized tuberculosis. When a tuberculous process advances from its minute miliary lesion to develop a conglomerate mass of tubercles undergoing caseation there is brought into action a large number of endothelial cells of the migrating type. These cells can often be recognized, as they are advancing towards the tuberculous

process, by the presence of carbon pigment in their cytoplasm. They accumulate in considerable numbers until the aggregate amount of carbon gives macroscopic evidence of their presence. These endothelial leucocytes are found in all zones of the active tuberculous processes surrounding the area of caseation, and as they suffer necrosis the inert carbon becomes merged in the necrotic debris. The pale caseous material usually obliterates the naked eye evidence of the carbon content within the necrotic center. In the periphery, however, the migration of these pigmented cells leads to a more pronounced coloration of the tissues until a distinct zone can be differentiated from the outlying structures not influenced by the tuberculous process. Where the infection of the tissues is not great and where the cellular resistance prevents the rapid destruction of lung tissue, a proliferation of connective tissue follows upon the irritation induced by the infection as well as by the presence of the foreign pigment. There is no evidence that the fibrosis stimulated by the presence of the tubercle bacilli is any different from that taking place in a lung not involved in anthracosis. But the amount of fibrosis encircling areas of chronic tuberculosis in the presence of much anthracosis, is strikingly in excess of this. A rim of black tissue looking like black rubber extends for some distance, a centimeter or more, into the surrounding lung and it would often appear that the extent of the fibrosis is much out of proportion to the tuberculous lesion which it encircles. We have found that, after the early fibrosis developing in association with an anthracotic deposit has begun, the further development of anthracosis and fibrosis in this area becomes progressively worse, just as in normal tissues where, after the accumulation of a certain amount of carbon leading to the development of new fibrous tissue, a definite degree of sclerosis causes many of the phagocytic endothelial cells to be locally destroyed with the liberation of their carbon content in the tissue interstices. It is probably this free pigment which by irritation leads to further fibrosis of the area. We have no evidence that this free interstitial pigment calls forth a migration of new endothelial cells, but it seems probable that the local aggregations of these elements are mainly brought about by the tuberculous process.

Beitzke claims to have observed anthracotic cavities in areas of extensive pigment deposit. These, he believes, are unique in having no relation to a process of tuberculosis, but have developed directly within an anthracotic lesion. We have observed similar

cavities, not once but many times, in some of which remnants of a tuberculous process were demonstrated. These cavities are prone to lie at the apex of the lung, isolated and easily distinguished by their localized pigmentation from the remaining uninvolved tissues. At times the cavity is clear cut with a smooth pigmented wall showing a feeble attempt in the formation of a fibrous wall but without granulation tissue in its inner lining. At other times the cavity shows threads and trabeculae forming a very irregular contour of its inner boundaries. It has been our experience that where anthracosis of severe grade alone involved the lung tissue, the progress of the lesion was towards a denser and more solid mass, which, by shrinkage as well as by the continual accumulation of carbon, produced a structure of the consistence of hard black rubber. The inert nature of the greater mass of such areas does not readily permit of necrosis and liquefaction. We, therefore, are of the opinion that the presence of cavity formation within an area of anthracosis suggests the presence of an infective process, commonly tuberculosis.

The evidence that the tuberculous process of the lungs attracts the migration of phagocytic endothelial cells and that the accumulation of these wandering cells brings with it a deposit of pigment immediately surrounding the tuberculous focus, has a great interest for us whether the association is of favorable or unfavorable effect. By some, but without sufficient evidence for their stand, it is thought that anthracosis has a harmful influence on the tuberculous process. Others have taken a neutral stand and believe that the influence is for neither good or bad. I believe, however, that we can offer definite evidence both in our microscopic and our macroscopic specimens that the role of the anthracotic process is, in as far as localized chronic tuberculosis is concerned, a most favorable one in assisting the tissues capable of response in localizing the infectious process. We have observed not only that the carbon available in our urban communities is quite sufficient to serve the needs of this pigmentary fibrosis surrounding tuberculosis, but that the still greater quantity present in the air of coal mines permits the protective reaction to occur more rapidly and widely.

UNRESOLVED PNEUMONIA ASSOCIATED WITH SEVERE ANTHRACOSIS.*

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It is the object of this paper to emphasize the high percentage of instances in which we have found anatomical evidence of atypical or delayed resolution of the exudate in pneumonias developing in lungs already presenting severe anthracosis, and to call attention, from the teaching standpoint, to certain findings which have aided us in reaching our conclusions. About four years ago I reported the association of these lesions in an article based on the study of three years' autopsy material in Dr. Klotz's department at the University of Pittsburgh. Since the publication of this article I have continued the work on the autopsy material of the Allegheny General Hospital and have continued to find a very high percentage of instances in which the association has occurred.

In the University of Pittsburgh Series were reported the results of the study of the autopsies which occurred during the years 1910, 1911, and 1912. Thirty-eight cases of lobar pneumonia were studied. Nine instances were found where the exudate had not cleared up and was evidenced either by abscesses, areas of organization, masses of undigested hyaline fibrin or by gangrenous foci. Four of these were associated with advanced anthracosis, two with anthracosis and severe fibrous induration, one with fibrous induration alone and two showed no local evidence of a possible cause for failure in resolution. In the Allegheny General Hospital Series thirty-five cases of lobar pneumonia have been studied since 1913. Eighteen have presented evidences of failure in resolution, seventeen of these showed more than a moderate degree of anthracosis, but because of infarction or generally distributed abscess due to septicaemia, six of the cases were not accepted in the series. The reason being that either of those conditions might have been responsible for the findings had no anthracosis been present. Of the remaining twelve instances of delayed resolution, eight were associated with ex-

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treme anthracosis, three with moderately severe anthracosis and only one with a minimum amount of anthracosis. Tabulating the two series studied gives the following result:—

	Total Cases	Delayed resolution	Associated anthracosis	Excluded because of other lesions	Without anthracosis
Univ. Pittsburgh Series....	38	9	6	1	2
Allegheny Gen. Hosp. Series	35	18	11	6	1
	—	—	—	—	—
Total	73	27	17	7	3

From the above it may be seen that we have had anatomical evidences of failure of resolution of the exudate in 37% of 73 cases of pneumonia occurring over a period of nearly seven years and collected from two somewhat differing communities. Of the instances of failure of resolution, 63% have been associated with more than a moderate degree of anthracosis, that being the only important co-existing lesion found.

It is difficult to obtain statistics from other communities, which are compiled in such a way as to be of use in comparison to our findings. Albutt's System contains the statements that gangrene has been recorded in only 37 out of 7,868 cases; that abscess is said by some to be slightly more common and by others less common than gangrene, and that the gradual organization of the exudate in alveoli is so rare that doubt exists as to whether it really occurs or not. The last edition of Osler's System states that abscesses have been diagnosed seventy-six times out of 12,030 cases and twenty-eight times out of 1,294 autopsies. In a series of cases reported from the Johns Hopkins Hospital, five cases of single abscess and four of multiple abscesses have been diagnosed in 658 cases. Gangrene is cited in the same reference as having been found one hundred thirty-six times out of 27,761 cases. Fabian (Johns Hopkins Hospital Reports, 1909), reported on the lesions found in one hundred and ninety-five autopsies of Lobar Pneumonia at the Johns Hopkins Hospital; he found organization in one case—thrombosis in five cases—abscess in three cases—suppuration in one case and gangrene in five cases.

Admitting that our figures do not apply fairly to the Pittsburgh district because of the unavoidable selection of a great majority of our autopsies from among classes whose occupations produce anthracosis of the lungs, and in spite of the fact that our series is still comparatively small, I am convinced that the exudate of pneumonia is less likely to resolve typically in an anthracotic than in a normal lung. In my former communication I suggested the closure of a large percentage of the perivascular and sub-pleural lymphatics, which is a constant occurrence in the anthracotic process, to account for the way in which anthracosis interfered with the usual method of healing in pneumonia, arguing that it interfered with drainage from the alveoli and led to the accumulation both of serous and cellular waste products, which remained in situ and prevented proper ferment action in digesting the exudate. Further studies are in progress in our laboratory by means of which we hope to show that this is actually the case.

The gross appearance of an anthracotic lung in any stage of pneumonia is very deceptive and unless one has had considerable experience it is impossible to estimate the degree of anthracosis present in a lung during an attack of pneumonia. If we take for example, a unilateral pneumonia, the unattacked lung may present marked anthracosis, showing a pleura of almost blue-black appearance and a cut surface of grey-black color while the attacked lobe or lung appears as a dark purplish-red or a pale gray depending on the stage of the disease. In the red stage the alveoli are filled with serum, blood and cells, and although some of the lymphatics become swollen and the pigment bearing cells become more or less free, these are too greatly out-numbered to influence the color. The surface, therefore, may be mottled with black spots but the general appearance is diffusely dark red. One may even wonder what has become of the pigment, but he has only to draw a clean glove over the cut surface to find it becomes as dirty as if he had drawn it over a dusty floor. In the gray stage the occluded lymphatics are marked by intensely black points on an otherwise gray surface. The explanation of this is simple. The black pigment bearing cells which are free are so widely separated by gray masses of exudate, that their color is entirely overshadowed and they are not seen. The pigment cells about the lymphatics are firmly bound in by connective tissue, are immovable and are compressed from a loose patch to a mere point by the pressure of the exudate about it.

In most instances it has been possible to diagnose areas of organization in the gross. The appearance is fairly characteristic. The color is usually brownish-yellow with large masses of black pigment distributed over it, and the consistency is more or less jelly-like and not nearly so firm as in the hepatized stage. Some of the alveoli appear to gape widely while others contain small white plugs which can not be expressed readily. The trabeculae may or may not appear thickened; when they do, they are seen as fairly broad white bands which often show borders consisting of black pigmented lines. Usually several adjoining lobules and sometimes practically whole lobes are involved in the organizing process.

The gross changes are borne out by the microscopic findings. In the early stages the red color is shown to be due to the character of the early exudate. In an anthracotic lung the actual number of free pigment bearing cells is always large during the early stages of pneumonia, but they are in a very small proportion as compared to the other elements of the exudate. The lymph spaces containing pigment cells which are not too firmly compressed by connective tissue become dilated allowing the cells to resume their spherical forms. In the later stages the free pigment cells are surrounded and greatly out-numbered by the polymorphonuclear leucocytes and fibrin. Those which are caught and bound firmly by the proliferated perivascular connective tissue are unaffected and they remain as great nests of compressed spindle shaped cells filled with pigment, and together with the connective tissue completely close the affected channels. In the organized areas the plugs are found to be undergoing healing through vascularization and connective tissue replacement. The abscesses are usually small, typical and show no unusual features.

CONCLUSIONS.

Atypical resolution in pneumonia has been encountered so commonly by us in anthracotic lungs, that we believe there is a definite relation between the two conditions.

The anatomical changes resulting from atypical resolution are sufficiently characteristic in the majority of instances, to be readily determined in the gross.

INCOMPLETE TRANSPOSITION OF THE GREAT VESSELS IN A GIRL OF SIXTEEN.*

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Among the anomalies of the heart, those at the base probably occur with greatest frequency, and transposition of the great vessels given off at the base is not an uncommon condition. The partial transposition of the great vessels in which the aorta arises from the right ventricle, along with a stenosed pulmonary artery, has been reported in the literature in considerable number. As a rule, these anomalies are observed early in life, as the anatomical alteration is so great that the life of the individuals is very short, so it is with unusual interest that we look upon anomalies of the heart in older individuals, and we wish here to present the findings of a case in which the aorta and pulmonary artery arose from the right ventricle in reversed positions; that is, the aorta arose to the right and anteriorly to a very small pulmonary artery which was situated to the left and somewhat posteriorly. Associated with this condition, there was also a perforate septum, patent foramen ovale, and closed ductus Botalli.

The case in question was that of a girl, aged sixteen, of Croatian descent, who entered St. Francis Hospital, September 22, 1916, and was admitted to the service of Dr. B. A. Cohoe. She complained of shortness of breath on slight exertion and showed marked cyanosis of the mucous membranes and fingers. These symptoms began four years ago, with a gradual onset and no particular discomfort, except some difficulty in breathing on slight exertion. Within the past year, the shortness of breath became very much more marked.

On physical examination, the precordium bulged slightly, without evidence of abnormal pulsation. The apex beat was distinctly visible. Examination showed the heart enlarged 2 cm. beyond the right border of the sternum. The left border could not be located. Over the mitral area, there was a loud systolic murmur, which was transmitted to the left, and also a short diastolic murmur. At the pulmonary area, there was a loud systolic murmur, which was the same in character as the one at

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the apex. The electrocardiogram showed an enormous preponderance of the right heart, with an unusual exaggeration of the P Wave in Lead 2. There was a very marked increase in the red cells, amounting to 10,660,000. With a corrected Sahli instrument, the hemoglobin was found to be 180%. Owing to the thickness and viscosity of the blood, it was impossible to obtain a preparation from which an accurate differential count could be made.

On October 26, the patient came to autopsy. External examination of the body showed that although the individual was in the adolescent state, there was an absence of axillary and pubic hairs. The skin was deeply cyanosed, and the tongue and mucous membranes were swollen and deeply colored. Inspection of the fingers and toes showed a broadening of the terminal phalanges, with rounded-off prominent nails which were deeply discolored. There was no oedema of the lower extremities. The important findings at autopsy were those referable to the heart.

On opening the pericardium, a small amount of clear straw-colored fluid was found within the sac. The pericardial surfaces were smooth. On the precordial surface of the right ventricle, there was an irregularly triangular-shaped pearly white thickening, 2 x 2 cm. in size. A number of pin-head sized, discreet bright hemorrhages were observed beneath the pericardium of the right auricle. A large amount of thick, almost black, blood escaped from the cavities. The organ weighed 365 grams and measured 10 x 9 x 8.5 cm. The apex was very broad and rounded-off. It was slightly lower on the right side and measured 4.5 cm. across. Examination of the great vessels at the base of the organ showed what appeared to be only one large artery leaving the heart. This was given off from the right ventricle. From external examination, the aorta seemed to be wanting. With this anatomical peculiarity in mind, the right heart was opened in the usual way, and on cutting upward behind the tricuspid valve, the right ventricle was found to be drained by the large vessel noted above. The valve guarding this orifice consisted of two cusps anteriorly and one posteriorly. Just beneath the posterior cusp and extending about half way beneath each anterior cusp, there was an opening in the interventricular septum, irregularly oval in shape, and measuring 2.5 x 0.8 cm. The opening was above the musculature of the interventricular septum. As the under surfaces of the posterior cusp and part of the other two cusps formed the upper boundary of the oval, it would appear that the opening occurred

just beneath the semilunar ring. On looking through the opening, a valve-like structure and chordae tendineae were seen, which were later found to be the posterior surface of the mitral valve. When the left heart was opened, it was found that by passing the finger up behind the mitral valve, it came out through the opening just described above.

The right auricle was greatly distended and the appendage took part in the general cavity of the auricle. The wall of the auricle was very much thicker than usual, measuring 0.3 cm. A very fair musculature was developed within the wall which was evidenced by examination of the interior of the auricle where there were columns of muscle closely resembling, although less marked than, the columnae carnae of the ventricle. Laterally and antero-posteriorly, the auricle measured 5.8 cm. across, and the appendage extended well over on the heart in front of the vessel given off from the right ventricle. The foramen ovale was patent for a good-sized goose quill, but was well guarded by a valve-like structure. The tricuspid valve measured 9 cm. and its auricular surface presented clusters of granular vegetations which were gathered together at the attachment of the chordae tendineae to the individual valve leaflets. Although more numerous at these points, there were, however, several smaller granular dots distributed between the more prominent areas. Some of these vegetations were quite red in color, although the majority of them were pale and fairly firm. They had a distinctly warty character and appeared to be of comparatively recent origin. In addition, a number of tiny congested vessels were seen coursing in from the base of the valves toward the accumulations at the borders of the cusps. The ventricular side of the valve was free from vegetations. The chordae tendineae were heavy and formed rather broad bands at their attachment to the thickened edges of the valve leaflets. In turn the chordae tendineae were given off from columnae carnae which were unusually developed in number and size for the right ventricle. On passing upward behind the tricuspid valve, it was found that the incision extended into the only large vessel leaving the heart. Thus it was found that this large artery drained the right heart. The vessel was guarded by a valve having one posterior and two anterior cusps. The right coronary artery was given off from behind the right anterior cusp, while the left coronary artery had its origin behind the posterior cusp. The opening of the valve measured 6 cm. across. The posterior and right anterior cusps were separated in the

normal way by a cleft, while the edges of the posterior and left anterior cusps were adherent, as were also the two anterior cusps. At these points of adhesion there were thick grayish red granular vegetations on the ventricular aspect. These vegetations were quite flat and rubbery to the feel. At one place behind the tricuspid valve there was a milk-white spot on the endocardium measuring 1.2 x 0.9 cm. The musculature of the right ventricle was of a healthy red color and measured 2.1 cm. thick near the base and 1.8 cm. near the apex. In some places the epicardial fat could be seen entering the musculature, and in a few places some white scars were noted in the wall. Just below the semilunar ring and above the musculature, was the oval opening in the interventricular septum measuring 2.5 x 0.8 cm. At a distance of 1.5 cm. to the left of this opening, and 0.7 cm. below the left anterior cusp, there was a small triangular-shaped opening which measured 1 x 0.4 cm. The cleft had rounded-off milky white edges which were arranged in the form of an isosceles triangle with the equal sides showing a tiny indentation at the apex and at their communication with the base. On looking into this opening, it was observed that the edges were slightly overhanging, and in this respect suggested rudimentary valve leaflets. A small pliable probe passed through this opening was found to come out at the apex of a rounded cone-like projection which was found to lie in the lumen of a thin-walled artery situated just to the left of the large artery at the base. The exit of this channel from the right ventricle passed through the fleshy muscular wall and upper right ventricle for a distance of 2 cm. Thus it would appear that, assuming that the triangular orifice seen from the right ventricle was the pulmonary valve, the proximal portion of the pulmonary artery lay within the musculature of the heart. The top of the cone-like elevation had a rough granular appearance and measured 0.4 cm. across. The opening in this area measured 0.2 cm. This cone-like projection with its opening was given off from the right ventricle at the level of the base of the heart and considerably above the level of the valve for the larger vessel given off from the right ventricle. The main trunk of the pulmonary vessel at this point measured 2.5 cm. across, and a dilated pocket was formed about the cone-like projection. This pocket extended for some distance into the wall of the ventricle below the projection. The vessel broadened out slightly as it left the base of the heart, and immediately branched into two divisions which could be traced into the lungs.

It is difficult to understand the presence of the relatively wide pulmonary artery as it lay below and to the left of the aorta. This artery was thin-walled and, as stated above, 2.5 cm. wide. The only communication with this vessel was through the tiny orifice representing the anomalous channel of the pulmonary artery coming from the right ventricle. It is not possible that a large amount of blood passed through the pulmonary from this source.

On opening the left heart the auricle showed a smooth pale lining, save on its posterior surface over an area 0.7 cm. in diameter, where the endocardium was congested and roughened. The cavity of the auricle communicated with the appendage through a small opening. The left auricle communicated with the right auricle through a patent foramen ovale which would pass a glass rod measuring 0.6 cm. in diameter. The mitral valve measured 8.5 cm. across. On the auricular surface of the mitral, there were clusters of granular vegetations a little back from the edge at the points where the chordae tendineae were attached, of grayish red color and pin-head size. One vegetation, however, was arranged in the form of a slightly elevated ridge measuring 0.8 x 0.2 cm., and was situated posteriorly, with about an equal part on both leaflets and back from the edge of the valve and parallel to it. The valve showed some old white thickenings beneath the newer vegetations, and several smaller congested vessels were seen coursing toward the margin of the leaflets. The left ventricle measured 1.3 cm. thick in all parts. The epicardial fat extended into the muscle in some places, and near the apex several small white scars were seen in the muscle. The chordae tendineae were quite heavy and the columnae carnae well developed. On passing the finger up behind the mitral valve, it passed through the opening in the interventricular septum into the right ventricle, described under the right heart. On looking upward behind the mitral valve, it was found that one could see the under surface of the valve leaflets guarding the orifice of the large vessel which was given off from the right ventricle, which was the aorta.

When the aorta was followed upward, it was found to form an arch from which three vessels proceeded to the neck. The arch descended and formed the great arterial trunk of the lower body. This vessel was traced to its division into the common iliac arteries. Examination of the intima of the vessel showed it to be smooth, with no fatty plaques and no nodules about the openings of the intercostal arteries. The vessel measured 27 cm. in length from the arch down and was quite elastic.

The ductus arteriosus was firmly closed. There was only a small dimple at the point of its insertion into the aorta. The right bronchial artery was unusually dilated, being as much as five times its usual diameter. At its origin this vessel was directed upwards. The vessel walls were thin. The left bronchial artery was only slightly dilated.

All of the veins at the root of the neck were greatly engorged with blood, so that their diameters were much increased. In the vertebral column, just posterior to the heart, there was a deviation to the right which seemed to conform to the size and position of the heart.

THE PERSISTENCE OF CRANIAL BONE ANLAGEN IN COMPLETE ACRANIA.*

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In monsters showing grossly a complete acrania, the tabular cranial bones may nevertheless be represented by rudimentary calcareous formations arising through a process of intra-membranous osteo-genesis. In a still born eighth-month foetus, showing craniorrhachischisis, acrania, exencephalia and a correspondingly severe degree of agenesia, aplasia, hypoplasia and dysplasia in various portions of the central nervous system, the character and extent of such cranial bone rudiments have been studied in several hundred sections used for teaching purposes, and in every section such formations have been present. They occur as irregular, somewhat angular masses which are heavily impregnated with lime salts, as is shown by their intense blue-black staining with hemalum, and which vary in size from small granules up to masses nearly 100 microns in length. In association with such bone rudiments are to be found those structures which are concerned in the normal process of intramembranous osteo-genesis; coarse fibre bundles; large angular connective tissue cells, the so-called bone corpuscles; and a ground substance which in the foetus shows marked staining reactions for connective tissue mucin. The lime salt deposit seems to occur in and upon the

*From the Department of Pathology, University of Michigan, Ann Arbor, Mich.

Presented at the Meeting of the International Association of Medical Museums, New York, April 5th, 1917.

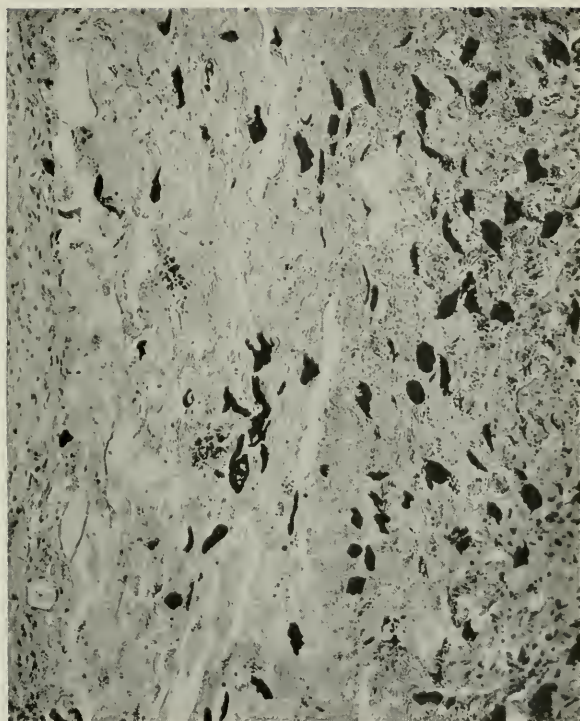


FIG. 1.—MICROPHOTOGRAPH OF RUDIMENTARY CRANIAL BONE ANLAGEN IN CASE OF ACRANIA. SPICULES OF ATYPICAL BONE FORMATION DEEPLY STAINED BY HEMALUM.

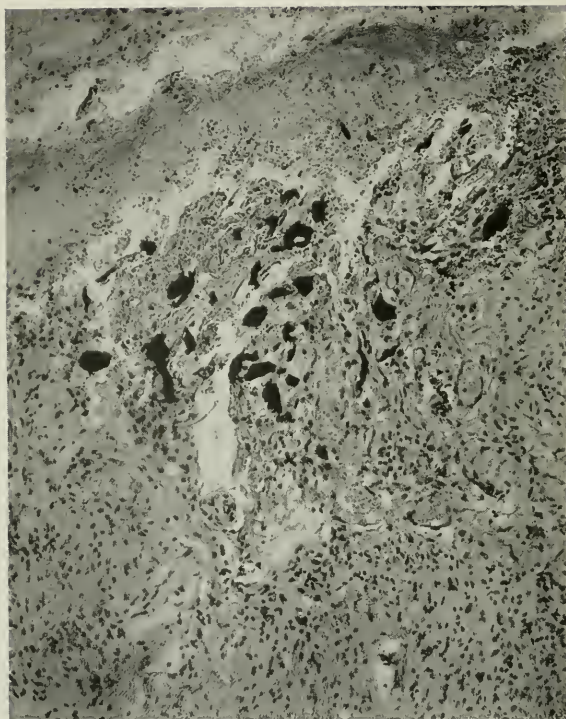


FIG. 2.—MICROPHOTOGRAPH SHOWING RELATIONSHIP OF RUDIMENTARY CRANIAL BONE ANLAGEN TO BRAIN IN CASE OF ACRANIA.

fiber bundles and is first noted as minute spherical bodies which mass together to form the characteristic angular structures.

In its finer detail, osteogenesis as found in this case of acrania is quite comparable to normal intramembranous ossification. It differs, however, in that no large bony masses are found. The calcareous spicules remain separated from each other, and scattered throughout the matrix without any formation of the radiating bars of bone found at the advancing border of the normal process. Nor is there evidence of inclusion of osteoblasts in the matrix to form bone lacunae. (See Figs. 1 and 2.)

As might be expected from the marked developmental disturbance the distribution of the bone rudiments in acrania conforms but very roughly to anatomical relationships which might be considered as indicating areas of formation of particular cranial bones. It is more abundant however in the lateral portions of the area epithelio-serosa than beneath the area cerebro-vasculosa, and quite constantly is noted as occurring not just beneath the atypical integument but between a layer of nerve tissue and blood vessels externally and the hypoplastic brain tissue within.

The fact that intramembranous ossification has here proceeded but to a stage of detached spicules is interesting in view of the belief of many comparative anatomists that the intramembranous development of subcutaneous tabular bones is phylogenetically comparable to the formation of the integumental skeleton of certain lower vertebrates and that this in turn had as its precursor the formation of dentinous cutaneous spines.

ON THE TECHNIQUE OF OBTAINING SAMPLES OF
ALVEOLAR AIR FOR ESTIMATION OF THE CAR-
BON DIOXIDE TENSION, WITH ESPECIAL
REFERENCE TO THE ROTH MODIFICA-
TION OF THE PLESCH- HIGGINS
METHOD.*

BY MAUDE E. ABBOTT, M. D.
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Among the many advances which have taken place in physiological knowledge in very recent times, none has had a more important or direct bearing upon the practical issues of clinical medicine than that which has established the specific chemical reaction of the blood as what may be termed a definite physiological constant, the variations in which imply corresponding degrees of disordered tissue metabolism, and the graver deviations, cellular and somatic death. In this sense, the maintenance of the hydrogen-ion concentration or acid-base equilibrium of the blood and tissues at the normal level of very slight alkalinity, with fluctuations within very narrow physiological limits, has been aptly likened to the range of the body temperature, and supplies a similar index of metabolic efficiency.

Until quite recently the exact determination of the blood and tissue reactions has been a complicated procedure beyond the scope of ordinary clinical application. But the rapid increase, during the last decade, of a knowledge of the factors that enter into its adjustment, and of metabolism in general, has yielded today a number of tests of quite easy application. These tests are based upon the now well known facts that the normal processes of metabolism are associated with extensive production of carbon dioxide and other organic acids, which are being constantly received into the blood stream, where they are as quickly neutralized by the various basic substances, carbonates, phosphates or proteins, held in weak solution there, and that conversely the disturbance in the normal proportions of any of these substances in the blood and tissues leads to an alteration of the acid-base equilibrium of the blood of the na-

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ture of a diminished alkalinity, recognized clinically under the term acidosis. The possible causes of such a disturbance are one with the factors that may enter into the adjustment of this equilibrium and may be enumerated as abnormal retention or over-production of acids, imperfect oxygenation and incomplete combustion of acid products, and diminished intake or lessened formation, or excessive excretion of bases. In each case the result is the same, — a pathological state of the body fluids incompatible with the proper functioning of enzyme reactions and those other delicate processes, the sum of which constitute life.

Of all the evidences of acidosis, or more correctly of hypo-alkalinity of the blood, the most constant is that yielded by the determination of its carbon dioxide content which is known to vary in inverse ratio with the organic acids present. This important point has been established by the findings, first of Haldane and Priestly,¹ who in 1905 showed that the rate of pulmonary ventilation was dependent upon the stimulation of the respiratory centre in the medulla by the carbon dioxide in the circulating blood, and secondly by the later observers, Winterstein and Hasselbach,² who proved that the stimulus thus supplied was not due to any specific property of the carbon dioxide, but simply to its acid nature, the facts being that all acids stimulate pulmonary ventilation. The extreme sensitiveness of the respiratory centre to very minute changes of the hydrogen-ion concentration was further demonstrated by Haldane and his co-workers³ in 1913. The result, therefore, of an increase of the organic acids in the blood will be a raised total acidity which will lead to an increased pulmonary ventilation, which will in turn lower the carbon dioxide content. The compensatory mechanism thus established has been well described and diagrammatically explained by Peabody⁴, who shows that the normal hydrogen-ion concentration of the blood is maintained by a fall in the carbon dioxide corresponding with a rise in its organic acids. The clinical importance of an understanding of these facts is self-evident. For since the fall in the carbon dioxide is directly due to the increased pulmonary ventilation brought about by the stimulus supplied by the increase in the total acidity, the whole process supplies a self-regulating and instantaneous means of control of the fluctuating chemical components of the blood stream. And since by the laws of diffusion of gases the carbon dioxide tension of the blood is identical with that in the alveolar air at the same moment, an

estimation of the tension in the latter is an easy method of ascertaining its tension in the blood, and conversely, the amount of the organic acids present as well. That is to say, a lowered carbon dioxide tension of the alveolar air will indicate a corresponding degree of hypo-alkalinity, or raised organic acid content, i. e., "acidosis," while *vice versa*, a raised carbon dioxide tension indicates hyper-alkalinity.

The technique of obtaining samples of alveolar air was first elaborated by Haldane¹. His method consists in collecting the air from the last part of a forced expiration, which the patient is directed to make into a rubber tube some four feet long and three-quarters to one inch in diameter, which is connected near the mouthpiece with a gas sampling tube. At the close of the forced expiration the air from it is retained in the tube by closing this off from the mouth-piece either by a valve or by the patient's tongue, and a portion is drawn off into the sampling tube for analysis. Four such samples are taken from four independent expirations, two made at the end of inspiration, and two at the end of expiration, the average of the four being taken for the result. During the experiment the nose is held closed by a clip.

The Haldane method has been used in a large number of important physiological and pathological researches, and in cases where it can be applied it remains unrivalled in accuracy and constancy of results as yielding the exact data upon the carbon dioxide arterial tension. But the fact that its application demands a certain amount of intelligent co-operation on the part of the patient means that its use is limited to subjects who are conscious, and not too weak to give intelligent co-operation, and it is, of course, inapplicable to infants. Plesch, in 1909,⁵ introduced a modification for use in those cases where the patient's co-operation could not be obtained, which is based upon the principle that the diffusion of gases in all parts of a closed space is equal, and that, therefore, continuous breathing into a closed chamber for a given time renders the carbon dioxide tension of the air in this chamber identical with that of the alveolar air.

The carbon dioxide tension of the air obtained in this way by the Plesch method is some two to six millimeters higher than that obtained by the Haldane method, and probably approximates the tension in the venous blood. It is not, therefore, so applicable as the Haldane method to strict physiological research, but it yields values sufficiently close for clinical pur-

poses and is valuable as being universally adaptable to patients in all conditions of consciousness. Its accuracy was confirmed in 1911 in a long series of observations by Porges, Leimdorfer, and Markovici.⁶ As modified by Higgins⁷ and later by Boothby and Peabody⁸ it has been the basis of extensive studies made at the Peter Bent Brigham and Johns Hopkins hospitals and at numerous other institutions on this continent.

The technique of the Plesch-Higgins method is briefly as follows. During the experiment the patient, whose nose must be closed by a clip, breathes through a mouth-piece which is connected with a three-way valve communicating with the outside air on the one hand, and a rubber bag on the other. The rubber bag used is an ordinary round bathing cap held tightly in place around the metal disc to which the mouthpiece and valve are attached, by a strong rubber ring. Immediately before the experiment this bag is filled with approximately one litre of atmospheric air by first expressing all the contained air with the hands, and then introducing a litre of air either by a rubber bulb or by attaching the bag by glass tubing to a closed empty flask from which the air is displaced by introducing a litre of water through a second tube. The patient begins by breathing the outside air. At the end of a quiet expiration the valve is turned so that the subject is connected with the rubber bag, containing the litre of air. He takes four or five rather deep and slow respirations from the bag in twenty or twenty-five seconds. At the end of the last expiration the valve is again turned and the subject thus connected with the outside air. Samples are then taken from the bag for analysis by the Haldane portable gas analysis apparatus.

From the above considerations it is readily seen that the estimation of the carbon dioxide tension of the alveolar air by the Plesch method supplies a test for acidosis of such universal routine clinical application that its reduction to the simplest and easiest technique possible becomes a matter of real importance. In an interesting little monograph describing various time-saving devices introduced by him in his study of alveolar air at the Battle Creek Sanatorium in Michigan, Dr. Paul Roth⁹ has suggested and introduced a modification of the Plesch method which adds to the simplicity of the technique. He simply substitutes, for the closed Plesch chamber, the long Haldane tube, connecting the patient by a valve below the mouth-piece with it for twenty-five seconds, during which time he is required to breathe naturally and moderately deeply in and out of the tube.

This method is based on the view that the great length of tube makes that portion of it nearest the valve and mouth-piece practically a closed chamber.

I am indebted to Dr. Walter M. Boothby for the suggestion that I should follow this Roth method instead of that of Plesch in cases to which the Haldane method is not applicable, and to Dr. Peabody for the advice that the results of my observations in the use of this method controlled by that of Haldane are of sufficient interest for publication. These results are given in the appended chart. It is of some interest to note that the difference in the carbon dioxide tensions obtained in my use of the two methods is higher than those in Dr. Roth's own experiments as cited in his article — that is to say, the carbon dioxide tension was in my cases from three to seven millimeters higher by the Roth method than by the Haldane, while Dr. Roth's figures for both methods (*loc. cit.*) approximate closely to each other. The difference obtained in my experiments is similar to that noted between the Haldane and Plesch methods under the Plesch-Higgins technique, and is what one would expect, theoretically, to find. In correspondence with Dr. Roth he agrees that my higher findings are probably to be explained by a greater length and diameter of tube, that used by me being 235 cm. long and 21 mm. in diameter, as against a tube used by him 195 cm. long and 16 mm. in diameter. The cubic content of my tube is thus 813 cc., an amount greater than the intake of a deep inspiration, thus precluding the possibility of contamination by inspired air, and converting the Haldane into a practically closed cavity, analogous with that of the Plesch bag.

Personal technique. In each case referred to in the chart the patient was placed at rest in a chair and the tube was clamped to an adjacent table at a convenient level. A rubber mouth-piece with a wide flange for insertion between the teeth and lips was attached to a Carnegie Institute valve with wide orifice, the opposite end of which was inserted into the long Haldane rubber tube. A piece of fine bore lead tubing obtained at the Chadwick Lead Company, Boston, inserted into the Haldane tube close below the valve, connects the space at this point with the sampling tube below.

The mouthpiece having been inserted without leakages and nose clip carefully adjusted, samples by the Haldane method were first taken. Here two large sampling tubes were used for duplicate analysis. In each tube four forced expirations, two given at the end of inspiration and two at the end of expiration, were

CHART SHOWING CO₂ TENSION OF ALVEOLAR AIR, DETERMINATIONS MADE BY ROTH METHOD WITH TUBE 215-235 CM. LONG AND 21 MM. WIDE, CONTROLS BY METHOD OF HALDANE

Date	Name and Med. No.	Sex	Age	Diagnosis	CO ₂ TENSION IN ALVEOLAR AIR			ACIDOSIS	
					Haldane Method (Normal = 38-40 mm.)	Roth Method (Normal = 42-46 mm.)	Difference between H. & R.	By Haldane and Roth Methods	By Ammon. Coefficient. (Normal = 4-7)
							mm.		%
1916 22/3	S. B. 23837	M	27	Diabetes	26.3	32.3	5.9	+	19.5 (+)
26/3					24.6	39.4	4.8	trace	10.3 (trace)
5/4					31.4	37.8	6.4	+	13.6 (+)
7/4					18.8	23.8	5.0	++	24.3 (+ +)
14/4					37.8	44.3	6.5	none	9.4 trace
18/4					32.9	36.4	3.5	trace	7.2 trace
21/4					29.9	34.9	5.0	+	8.9 trace
23/4					31.3	36.0	4.7	+	5.6 none
24/5					31.3	36.6	5.3	+	9.5 trace
25/5	H. K. 24112	F		Cerebellar Tumour	39.7	48.7	9.0	none	—
28/5					42.0	48.7	6.7	none	—
27/5	W. R. 24088	M	45	Diabetes	31.6	37.5	5.6	+	15.9 (+)
30/8	A. C. 24462	M	15	Diabetes	32.0	37.8	5.8	+	11.0 (none)
28/9	R. S. 24539	M	18	Diabetes	32.7	37.7	5.0	+	10.6 (+)
1/9	N. W. 24359	M	51	Diabetes	39.0	46.8	7.3	none	6.3 none

taken by negative pressure, so that the contents of the two tubes represents the average of eight forced expirations. Between each expiration the patient was disconnected and the tube ventilated, and a rest interval of one minute was provided.

The samples by the Roth method were taken at the same sitting but after a few minutes interval. The same mouth-piece was used as for the Haldane method, but it was inserted with even greater care, as leaks seemed more difficult to avoid. The patient was directed to breathe naturally, and moderately deeply, into the mouth-piece, which was connected with the tube for twenty-five seconds by stop-watch. Duplicate samples were taken, the patient disconnected and the tube ventilated between each. When the results of the first tube analysis bore the expected relation to the figures from the Haldane samples (which, as stated above, were analyzed in duplicate throughout), the sample in the duplicate tube taken by the Roth method was not always analyzed.

The experiments were made at various times of the day and without reference to the patient's intake of food, and he was not always kept rigidly at rest in the interval between the taking of the Haldane and the Roth samples, facts which may account for the rather wide variation of differences as seen in the chart.

In the chart the columns under Acidosis have been inserted to add corroborative interest to the findings. It will be seen that the indications of acidosis yielded by the ammonia co-efficient correspond closely with those obtained by the Haldane and the Roth methods. For these figures I am indebted to Dr. E. H. Mason.

Conclusions. 1. The Roth method yields similar results to those obtained by the Plesch, and provides a simpler form of apparatus of easy application at the bedside and adapted for use in unconscious or difficult cases, with whom the method of Haldane is not for one reason or another applicable.

2. The differences in the carbon dioxide tensions as obtained by these methods will depend upon the length and diameter of the tube and the length of time of the patient's connection with it. A tube approximately 235 cm. long and 21 mm. in diameter, that is, of a cubic content of about 813 cc., kept in place for exactly twenty-five seconds, yields a sample having a carbon dioxide tension averaging three to six millimeters higher than that of Haldane's sample taken at the same sitting. This difference approximates closely to the difference obtained

in the Plesch method and would therefore appear to be a suitable calibration to adopt as a standard.

I would take this opportunity of acknowledging my deep indebtedness to Dr. Walter M. Boothby for instruction in the technique and understanding of this work throughout, and I have to thank Dr. C. F. Martin for the privilege of making these observations on patients in his hospital service, and for stimulus in the work.

NOTE. Since this article went to press, I have had the privilege of discussing the Plesch method with Dr. Higgins, and he has shown me a very simple modification of the technique used by himself at present. A pear-shaped rubber bag of about 1,000 cc. capacity, with a long slender neck is filled to about 600 cc. with air by a rubber bulb, and closed by a clamp; a glass tube inserted in the neck is used for a mouthpiece and the patient breathes directly in and out through it. Samples are tested on Mariott's tubes, or transferred directly to the Haldane gas analysis apparatus and examined for CO_2 tension.

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ABSTRACTS

A NEW CONTAINER FOR PATHOLOGICAL SPECIMENS.*

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(*Journ. Lab. & Clin. Med.*, Vol. 1, No. 12.)

Owing to the difficulty in obtaining oil-tight closure of glass Museum jars, the author presents a substitute made of sheet celluloid which he finds excellent and for which he claims several distinct advantages. Thus the new containers are very light, are cheaper, and do not break. They are adapted particularly for small and medium sized specimens, very heavy organs naturally not lending themselves so well. The figures show the form of the celluloid preserving jar, and also the clarity with which the specimens can be demonstrated.

The containers are very simple to make. Clear sheet celluloid one-thirty-second of an inch thick is used for the front and back, and a similar material one-sixteenth of an inch thick for the sides. The sheet celluloid is cut in the required sizes by means of a photographic print cutter. The front and one adjacent side piece are sealed with a ten per cent solution of celluloid in acetone and pressed together. The same process is repeated on the opposite side. The back is then sealed to the two side pieces in a similar manner. The bottom and top segments are cut to fit the inside measurements of the container. The inner edge of the box receives a coating of the binding solution and the bottom piece is pushed into the end. All of the joints are now protected by an extra coating of the celluloid solution and the container is ready for the specimen. Frames or supports of small strips of celluloid may be made to hold the specimen suspended in the solution to which it may be attached by means of a silk thread. The strips may be fixed to the side by a small amount of the celluloid solution, thus fixing the specimen in any desired position. The container is now filled with the Russian oil preserving fluid and the top pushed in, after the upper edge has been moistened with the celluloid solution. Should there be any leaks, it is only necessary to wipe away the oil and put on a small amount of the binding solution, in order to render it oil tight. The sides of the container are now painted with a quick drying Jap-a-lac and the typewritten label attached on the front.

While there is a faint yellowish tinge to the celluloid, the specimens are seen more distinctly than in the glass jars. Specimens mounted this way have been dropped on the floor without breaking, and can be passed around for inspection of a class with much greater ease and safety than the ordinary museum jars.

* Presented at the Meeting of the International Association of Medical Museums, New York, April 5th, 1917.



FIG. I.



FIG. 2.

AN EVAPORATION-PROOF EXHIBITION JAR FOR FLUID PREPARATIONS.*

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*Assistant Curator of Invertebrate Zoology, American Museum
of Natural History.*

*(Proceedings of the American Association of Museums,
Vol. VI., 1912.)*

Many attempts have been made to evolve a type of exhibition jar which will be proof against evaporation, but without success. As a result of experiments to remedy this difficulty the writer, in collaboration with Mr. H. Mueller, has contrived a jar for small specimens which is certainly evaporation-proof. The idea is simple in principle and consists in enclosing specimen and preserving fluid in a glass tube of appropriate dimensions, sealed hermetically in the flame of the blowpipe, flattened at one end, and mounted on a suitable base or pedestal. (Fig. 1.) The process is as follows:

1. A piece of glass tubing of the requisite length and diameter is procured. One end is sealed and flattened (Fig. 2), the other being left open. The flattening is easily accomplished by sealing up the end of the tube, rotating it at the side of the flame, with one hand, while the superfluous knot of glass which forms at the sealing-point is removed by means of a glass rod held in the other hand. When this has been done, the sealed end is quickly withdrawn from the flame and gently but firmly pressed against a horizontal metal or asbestos surface, the tube meanwhile being held vertically. If this is carefully done a clean, flat bottom, upon which the tube can stand, is the result.

2. The specimen, previously mounted on a glass or vulcanite plate (black in the figures), is taken out of its fluid and inserted in the empty tube (Fig. 2). The specimen should be so mounted that the distance between it and the end to be sealed should be at least two inches.

3. The open end of the tube is now rotated evenly in the flame, care being taken to keep the specimen as far as possible from the latter to prevent shrivelling.* When the end of the tube is sufficiently softened in the heat, another short length is welded on for purposes of handling, and the rotation in the flame is continued for a few seconds.

* Presented at the Meeting of the American and Canadian Section of this Association, April 5th, 1917.

Quoted in the discussion on Methods of Mounting Animal Parasites at meeting of this Association, April 5th, 1917.

* If the tube is large or of thick glass, great care must be exercised as it must remain longer in the heat. A partial protection is afforded by keeping the tube wrapped in asbestos to the top of the mount. Much of the heat is thus absorbed.

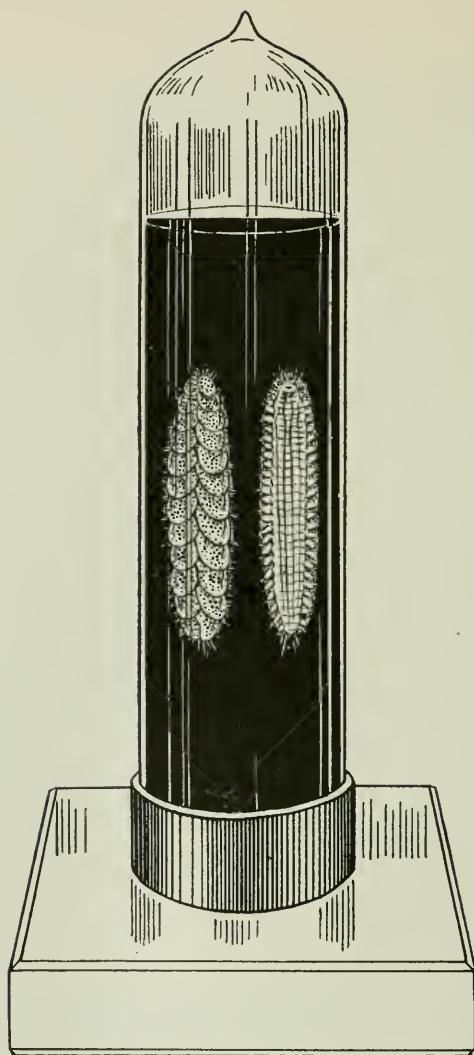


Fig. 1.

HERMETICALLY SEALED EVAPORATION-PROOF JAR FOR SMALL
SPECIMENS. NATURAL SIZE.

The tube is then quickly removed from the flame and the ends pulled quickly in opposite directions so that the heated portion is drawn out as a narrow tube. This is now cut off four to five inches from the enlarged portion, and the end of the latter molded symmetrically in the flame (Fig. 3).

4. The smaller tube is now heated near its junction with the larger, and then taken quickly from the flame, the open end inserted in the mouth, and by means of a short steady blow a bulb is formed (Fig. 4).



Fig. 2.



Fig. 3.



Fig. 4



Fig. 5



Fig. 6



Fig. 7

5. The bulb is then cut in half by marking it with a steel knife-edge and breaking it, (dotted line in Fig. 4). A funnel is thus formed (Fig. 5), through which, when the glass has cooled, the jar is filled with preservative to the top of the specimen mount, a pipette being used for this purpose.

6. The edge of the funnel is now brought into the flame, and a small glass rod welded to its margin to act as a handle for the next step in manipulation.

7. The jar is then held in one hand, the glass rod in the other, while the neck of the funnel is rotated in the heat, and slowly attenuated until cut off by the flame, the opening being gradually closed meanwhile (Fig. 6).

8. The jar is now sealed and ready for mounting. This may be done in a variety of ways. The writer uses a square pedestal of polished glass (see Fig. 1). The jar is set in a brass ring, silver plated, with gun-metal finish. A transverse piece of brass is soldered across the bottom of the ring, and at its center a brass pin is soldered. This latter is cemented into a hole drilled in the center of the pedestal, or a simple base may be constructed of polished hardwood with a hole sunk in the center to receive the jar.

A successful modification of this jar is made of flattened tubing, and is used in the storage collection for preserving rare specimens of small size. The flattened tube permits examination of the specimen with a low power of the microscope while sealed in the tube, and of course evaporation is impossible.

A METHOD OF OBTAINING DUPLICATE RECON- STRUCTIONS FROM THE ONE SERIES OF WAX PLATES.

FREDERICK D. WEIDMAN, M. D.

Philadelphia.

(New York Medical Journal, March 3, 1917.)

(The following method, which, so far as is known is original with the author, will be found of much value where a duplicate model is needed.—Ed.)

In making reconstructions the outlines of the magnified serial microscopic sections are traced upon successive wax plates, later cut out from them (positives), then carefully superimposed in numerical order, thus building up an enlarged reproduction in wax of the original. That part of the wax plate remaining after the essential part has been removed is ordinarily discarded and melted into new wax plates, but when the duplicate is desired it is this part that is saved and used. We may call this the negative. It will contain a hole, showing the outline of the original, and it is proposed to fill this in with plaster of Paris and thus produce a duplicate.

To this end the negatives are also kept in numerical order and superimposed. The plaster of Paris will be placed in the resultant cavity at a stage depending on the complexity of the subject. If simple, such as a rounded body, the whole series may be built up at once, the various

plates held together by transfixing with pins or sealing the edges with hot iron, and the plaster poured in through a hole in the last plate. When the subject is complicated, as with the writer's material, such as a fluke with tortuous ceca, presenting structures which will appear in the superimposed negatives as diverticulae, passing in all directions and which will not permit the entrance of the plaster unless they extend obliquely or directly downward, this difficulty is met by pouring the plaster in in installments, the worker piling up the plates until he finds that he is about to close over the vault of some space, when he will pour in sufficient plaster to fill it flush with the level of the last plate. The building up process with wax plates then continues until another vault is about to be covered, when another portion of plaster is poured, and so on until the whole has been completed. The worker is on the alert during all this time for spaces into which the plaster will not run; not only do vaults fall into this category, but also *winding* channels passing from below upward. Installments must be continually made to these.

To prevent too quick setting of plaster during this slow upbuilding, gelatin, two to four per cent may be added to the water to retard the setting and allow the different strata to commingle. A 2.5 per cent solution is the most useful in winter. The proportion of plaster and water also influences the rate of setting. The following recipes may be used:

- No. 1. 100 cc. gelatin solution (2.5 per cent).
15 rounded teaspoonsful of plaster.
Can be poured for four hours.
- No. 2. 100 cc. gelatin solution (2.5 per cent).
10 rounded teaspoonsful of plaster.
Can be poured for eight hours.

Both are firmly set by the next morning.

The addition of cotton fibres reinforces the model, is particularly useful in more or less delicate branches, and is accomplished practically by soaking pledgets of absorbent cotton in the slow set plaster and packing loosely into the pockets instead of pouring the plaster.

After the negative has been thus filled it is set aside until its contents have set. A portion of the plaster may be kept outside as a control or a needle run into the negative. After it has set it is then placed in a basin in a paraffin oven or hot air sterilizer at a temperature sufficient to melt the wax encasement. When the wax has run off the contained plaster model will reveal a duplicate positive, slightly larger than the original, but otherwise exact, whose exterior must be smoothed and finished as in the case of the original. More care will be required in finishing the duplicate because the plaster cannot be worked as easily as the wax. Where it is known that the model will have branches or constrictions which might break under the weight of the specimen during the melting process, provision must be made to *suspend* the mass over the basin. This is easily accomplished by embedding string in the plaster during the building-up process.

REPORTS

REPORT OF THE TENTH STATED MEETING OF THE AMERICAN AND CANADIAN SECTION OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS.

The American and Canadian Section of this Association held a highly successful meeting at the Academy of Medicine, New York, on April 5th, 1917. There was a large attendance of members representing the leading Medical Museums and Laboratories of the United States and Canada.

The following new members, having been approved by Council, were elected active members of the International Association of Medical Museums:

Dr. Ewing, Dept. of Pathology, Cornell University, New York; Mr. E. B. Ellis, Hôpital Français, New York; Dr. Stuart Graves, University of Louisville, Kentucky; Mr. Carl Kellner, Yale University, New Haven, Conn.; Mr. W. M. Johnson, Surgical Research Laboratory, Bellevue Hospital, New York; Dr. Ralph H. Major, University of Kansas, Rosedale, Kansas; Dr. J. W. McMeans, University of Pittsburgh, Pittsburgh, Pa.; Mr. Wm. Muir, McGill University, Montreal; Dr. R. E. Sheldon, University of Pittsburgh, Pittsburgh, Pa.; Dr. T. Wingate Todd, Lakeside Hospital, Cleveland, Ohio; Dr. F. S. von Wildner, Battle Creek Sanatorium, Battle Creek, Mich.; Dr. Fred Weidman, University of Pennsylvania, Philadelphia, Pa.; Dr. Hubert Schmidt, Veterinary Department, Agricultural & Mechanical College of Texas, College Station, Texas; Mr. Clifford C. Whitney, Veterinary Department, Agricultural & Mechanical College of Texas, College Station, Texas; Dr. Harry M. Martin, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pa.; Dr. W. J. Crocker, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pa.; Dr. G. W. Phelan, Long Island College Hospital, Brooklyn, N. Y.; Dr. L. Gross, Royal Victoria Hospital, Montreal; Dr. David Yates, Manhattan Eye and Ear Hospital, New York; Dr. Adolph Meyer, Phipps Clinic, Baltimore, Md.

The following officers were elected for the ensuing year :

President, Dr. O. Klotz, Pittsburgh, Pa.

First Vice-President, Dr. W. M. L. Coplin, Philadelphia, Pa.

Second Vice-President, Dr. H. E. Robertson, Minneapolis, Minn.

Third Vice-President, Dr. D. S. Lamb, Washington, D. C.

Councillors: Dr. A. S. Warthin, Ann Arbor, Mich.

Dr. W. M. L. Coplin, Philadelphia, Pa.

Dr. Howard Karsner, Cleveland, Ohio.

Dr. M. C. Winternitz, Baltimore, Md.

Dr. R. A. Lambert, New York.

Secretary-Treasurer, Dr. Maude E. Abbott, Montreal.

Assistant Secretaries: Drs. Joseph Kaufmann and Louis Gross,
Montreal.

The Morning Session was devoted chiefly to matters of business and the afternoon to Papers and Demonstrations. The proceedings were attended by the liveliest interest.

In his opening Address, the President, Professor Oscar Klotz of Pittsburgh, remarked upon the circumstances of national interest surrounding the occasion of this meeting, in that the Declaration of War by the United States had just been made and the thoughts of all were concentrated upon the needs of their country and upon the call that was being made to each to do his utmost in the public service. At the close of the Presidential address, Professor A. S. Warthin of Ann Arbor pointed out that this Society—with other scientific societies—should at once place its services at the disposal of the American Government and moved a resolution that a message to this effect should be sent. The following telegram was accordingly framed by the meeting and despatched to Washington:—

“The American Section of the International Association of Medical Museums places itself on record as wishing to serve the American Government in the present emergency and offers the services of its workers and resources in its special field of Research in any way the National Committee may suggest”.

(Signed) OSCAR KLOTZ, President.

April 5th, 1917.

The Minutes of the 9th Stated Meeting were submitted by the Secretary-Treasurer and accepted, together with the following financial statement for the current year:—

FINANCIAL STATEMENT OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS.

From April 28th, 1916, to April 2nd, 1917.

(Being the Report submitted to the New York Meeting of the American Section, and accepted April 5th, 1917.)

Cr.

April 28, 1916. Balance in bank.....	\$321.76
Received in members' fees:	
April 25th to February 5, 1917.....	\$ 76.27
February 6th to February 23rd.....	60.65
February 24th to April 2nd.....	52.60 \$189.52
Interest on Strathcona Fund, July, 1916.....	150.00
Interest on Strathcona Fund, October, 1916.....	50.00
Interest on Strathcona Fund, April, 1917.....	100.00 \$300.00
Bank interest to date:	
May 31st, 1916	2.30
November 30th, 1916	4.77 \$ 7.07 496.59

Dr.

Stamps	\$ 24.20
Cash books	1.80
Stationery	16.88
Bookkeeping & Financial Statement.....	55.00
Additional Typewriting	2.05
Expenses, Washington Meeting	55.00
Expenses, New York Meeting	50.00
Bulletin	411.10 \$616.03
Balance in bank	202.32
	\$818.35 \$818.35

A communication from Mr. Paul Rea, Secretary of the American Museums Association, dated May, 1916, which had been received by the Secretary too late to be submitted at the last meeting, containing a cordial invitation to participate in the proceedings of the meeting of the American Association of Museums in 1916, was then read.

The presence of a delegate from the American Museums Association in the person of Dr. Roy W. Miner of the Natural History Museum was announced and welcomed. Dr. Miner spoke at length, extending the greetings of the American Association of Museums and their cordial invitation to this Association to send a delegate to their meeting in New York on May 21st-23rd next, and said he was present with official instructions to do everything in his power to promote a closer association or affiliation between the two societies and to assure the members of the Medical Museums Association of the great interest which the American Museums

Association, as a whole, had in solving the problems which both Associations have in common and which are of a nature upon which a consensus of discussion must always lead to fruitful results.

Dr. Abbott recalled to the minds of the members that the subject of affiliation with the American Museums Association had already been debated at length at the meeting of 1908, and that a full report of the proceedings at that time had been published in Bulletin No. II. The greetings of the American Association of Museums had been warmly accorded to the Medical Museums Association on its organization at that time, and an invitation to affiliation was given then, but it was felt after due deliberation between representatives of both bodies that the time was not yet ripe to affiliate.

In the discussion which followed it was felt that the time was now ripe for a closer union between the two Societies, and it was moved by Dr. Coplin of Philadelphia, seconded by Dr. Karsner of Cleveland and resolved: That the kind invitation of the American Museums Association for a delegate to their meeting be accepted with thanks and that the closer relationship of the two societies be established by the interchange of proceedings and by participation in the annual meetings of each through the attendance of delegates who shall have all the privileges of these meetings excepting only the right to vote. Dr. Maude Abbott of McGill University was appointed as delegate to the meeting on May 21st-23rd next.

The establishment of a Central Bureau for the permanent preservation of the results of Scientific Research, especially historical material, for purposes of study by scientific workers throughout the country, a matter which had already occupied the attention of this Society in the years 1912-13 was brought forward by Dr. Winternitz of Baltimore, and a Committee consisting of Drs. Winternitz, Loeb, Haythorne, Karsner, Warthin and the Secretary *ex officio* was appointed to organize such a Central Bureau.

A discussion took place on the clashing of the time of meeting of the four Societies now presenting programmes of kindred interest in the city, namely, the American Association of Pathologists and Bacteriologists, the American Section of the Medical Museums Association, the Cancer Society, and the American Association of Immunologists. It was felt that in the common interest of all, some sort of federation should be attempted, so that subjects of common interest might be presented to combined audiences, and the President of this Association was empowered to confer with the Councils of the other Societies to secure mutual co-operation upon the programme, place and time of meetings, with this end in view.

A report of a most successful character was presented by Dr. Klotz from the Committee on the Organization of an American Source of Supply of Square Glass Museum Jars. Through the efforts of this Committee, arrangements had been made with a Pittsburgh firm to manufacture these jars in ten standard sizes and a sample jar had been submitted by this

firm of a satisfactory character, to be supplied at "duty free" prices to members of the Museums Association and scientific institutions, provided a sufficient number of orders were received before a given date. A circular letter to this effect, stating sizes, with prices, had been sent to all the members of the Association and a sample jar submitted to a number of the largest institutions represented, and orders amounting to some \$2,000 had already been received by the Secretary.

In the discussion that followed approval of the success that had attended the action of the Committee was expressed. The sample jar manufactured was pronounced as good and in some respects better than the German jars, and the prices were as moderate. The solution of a difficult problem appeared within reach, and a hearty vote of thanks was passed to the Committee, and especially to Dr. Klotz, for the excellent work accomplished.

Dr. Klotz pointed out that orders amounting to some \$5,000 were required by the firm before the manufacture could be undertaken on account of the initial expense of moulds, and the consequent necessity of increased orders for jars if the Phoenix Glass Company was to fulfil its offer. It was therefore recommended that this subject be brought before the American Museums Association by the Secretary at their next Annual Meeting and orders be invited from Scientific Museums, or institutions. It was decided that all transactions should remain between the Museums Associations and the manufacturing firm undertaking the work and that a commercial intermediary was not wanted for the present.

The following programme, upon Museum and Laboratory Technique, Microscopic Technique, Museum Teaching and Presentation of Results of Medical Research was presented.

1. *On the Making of Glass Frames for Mounting Specimens in their Correct Anatomical Relations, in Square Glass Museum Jars.*—E. L. Judah, Montreal.

The specimen is to be placed in its correct anatomical position in a jar of a size selected to fit it from a graduated series kept in stock.* It is attached to the glass frame, which is also made to fit the jar, by fine threads so inserted as to suspend it from the top and stretch it from the sides and bottom. The ends of the thread are left long and lightly tied at first to allow of readjustment, and are tied firmly later and clipped and their knots concealed only after the whole mount is finally completed and made permanent. The frames are made out of first-class soda-glass rod of suitable thickness which is bent into a square, overlapping the free ends at one corner where they are fused and annealed in a white flame by shutting off the air blast from the blowpipe. With very heavy rod all the corners must be annealed. Feet are attached by heating the bottom of the frame and pressing down two pieces of rod, the length of

* For sizes recommended see "*Series of sizes for Square Museum Jars in use at the Medical Museum of McGill University,*" Montreal, Canada, by E. L. Judah, Bulletin V, p. 89.

the width of the bottom of the frame, against the bottom of the frame with which they must be thoroughly fused and annealed. After the feet have been fused on and the bottom of the frame is cold, a cross bar is attached above to steady it in the jar. This is done by cutting a piece of rod the width of the top of the jar and applying it across the middle of the top of the frame, heating both at the point where they touch and fusing and annealing here. In the finished frame the bottom should appear pressed up above the feet and its top should be slightly below the cover of the jar. It may be placed either towards the front, or towards the back, or in the middle of the jar.

2. *Watch-Glass Mounting for Museum Specimens, with Elaterite Sealing*.—Dr. J. J. Mackenzie, Toronto.

This method is described in a paper received too late for insertion in the proper place. See page 415.

3. *Use of Celloidin for Museum Jars and Laboratory Purposes*.—Mr. Carl Kellner, Yale. (Abstract published in this issue.)
4. *Methods of Mounting Animal Parasites in Solutions, Including the Use of Plaster Paris*.—Dr. Fred W. Weidman, Philadelphia. (Published in this issue.)

In the discussion following, Mr. Roy Miner described the construction of an evaporation-proof jar for small specimens, published in abstract in this issue.

5. *Note on a Modified Sugar Solution as a Final Preservative for Museum Specimens*.—E. B. Ellis, Hôpital Français, New York. (Published in this issue.)
6. *Some Practical Devices in the Laboratory*.—Dr. S. R. Haythorne, Pittsburgh. (Published in this issue.)?
7. *Anthraxis Associated with Chronic Tuberculosis*.—Dr. O. Klotz, Pittsburgh. (Published in this issue.)
8. *Anthraxis Associated with Unresolved Pneumonia*.—Dr. S. R. Haythorn, Pittsburgh. (Published in this issue.)
9. *Preliminary Report on Syphilis of the Pulmonary Artery with Syphilitic Aneurysm of Left Upper Division: Demonstration of Spirocheta Pallida*.—Aldred Scott Warthin, Ann Arbor.

Study of a case in which the patient presented a definite history of chancre and skin rashes seventeen years before, with present symptoms of pulmonary haemorrhages and anaemia, Wassermann + + + +, and showing at autopsy active syphilitic lesions in heart, aorta, liver, pancreas, adrenals, testes, and an atherosclerosis and aneurysm of the pulmonary artery in the walls of which spirocheta pallida was demonstrated. Before death he had received one intravenous dose of 4 mg. of neosalvarsan and daily inunctions of blue ointment. This study places syphilis of the pulmonary artery and syphilitic aneurysm of this artery for the first time on a firm foundation as pathologic entities, as it is the first case in which the syphilitic etiology of pulmonary atherosclerosis and aneurysm has been conclusively demonstrated. The case is reported in full in the American Journal of Syphilis, October, 1917.

10. *On the Methods of Organ Reconstruction by Injection of the Arterial Tree. (with Exhibit).*—Dr. Louis Gross, Montreal. Discussed by M. C. Winternitz, Baltimore. (Abstract published in this issue.)
11. *Mesarteritis of Pulmonary Artery.*—M. C. Winternitz and H. Schmeisser.

Two cases of pulmonary mesarteritis (reported in full with a study of this subject in *Johns Hop. Hosp. Repts.*, XVIII, II, 1917, p. 145) were shown in which the specimens presented all the macroscopic and microscopic appearances characteristic of a syphilitic mesaortitis. In the first the chemical history, positive Wassermann, and presence of lesions elsewhere in the body indicate syphilis as the etiological agent. In the second a negative clinical history and Wassermann reaction made etiology less certain.

12. *The Persistence of Cranial Bone Rudiments in Complete Acrania.*—Dr. Carl Weller, Ann Arbor. (Published in this issue.)
13. *Incomplete Transposition of Vessels in a Girl of Sixteen.*—J. W. McMeans, Pittsburgh. (Published in this issue.)
14. *Note on an American Substitute for Russian Paraffin.*—A. S. Warthin, Ann Arbor. (Published in this issue.)
15. *Souchon Museum of Normal Anatomy.*—E. Souchon, New Orleans. (Published in this issue.)
16. *Demonstration of Ossific Centres in Embryos by Schultz Method.*—Wm. Muir, McGill University, Montreal.

The fresh embryo to be cleared is first placed in 95% alcohol and allowed to remain until completely shrivelled, usually from three to seven days, then remove to 1% KHO until transparent (from 4 to 48 hours) when it is transferred to 20% glycerin for a further period of 48 hours. If cleared sufficiently it may then be placed in ascending percentages of glycerin at an interval of two or three days, until finally in pure glycerin. Further references may be found in *The Anatomical Record*, 1905-06, by Franklin P. Mall; *The Johns Hopkins Hospital Bulletin*, 1906, by E. C. Hill.

17. *Specimen of Lower Jaw Cleared by a Modification of the Spaltcholz Method to Show Primary and Secondary Dentition.*—Wm. Muir, Anatomical Department, McGill University.

The specimen to be cleared is first placed in a 10% aqueous solution of hydrochloric acid until decalcified, then removed to 95% alcohol until completely dehydrated, when it is placed in xylol until transparent.

SPECIAL EXHIBITS.

The Exhibition of the Association was held in the Banquetry Hall of the Academy of Medicine and remained open for three days for the benefit of the Members of the American Association of Pathologists and Bacteriologists. It was largely attended and much appreciated. Special exhibits were shown from the Cornell Museum and the McGill Medical Museum, as well as the many interesting series which formed the subject of the papers and demonstrations of the Programme proper.

REPORT FROM THE COMMITTEE ON THE ORGANIZATION OF
AN AMERICAN SOURCE OF SUPPLY OF SQUARE
GLASS MUSEUM JARS.

The very enthusiastic discussion upon Museum Jars at the last meeting of the American and Canadian Section of this Association, and the favorable report from the Special Committee upon the development of an American source of supply, raised the hopes of all of our members that the long period of want of this important article, was to be broken. The situation at the time of our meeting seemed most favorable but, as will be recollected, our report at that time was made almost simultaneously with the declaration of war against Germany by the United States. In a very few days the picture of this country's activities was rapidly changing. The peaceful aspect of many industries took on a new color,—the adaptation of each man's work to the best need of a country donning its armor.

Our Association proposed a plan whereby the members could obtain a supply of museum jars of ten different sizes. These jars were to be obtained from an American Manufacturer (The Phoenix Glass Co.) at prices equal to those from the former German sources. The sample jars which had been examined by many of the members were found satisfactory, and in all respects the Association felt jubilant over what had been accomplished. Inasmuch as the manufacturer was bearing the entire expense of making the initial ten molds, they desired that a collective order of about \$5,000 be obtained by May 1st. This we had been unable to do, the entire orders from our members amounting to about \$2,000.

In spite of the best efforts of the Secretary, who attended the meeting of the American Association of Museums as a Delegate in May, and obtained the support of that body and a few additional subscribers, it was impossible to raise the combined orders throughout the summer beyond \$2,879.70. On the other hand, with the declaration of War by the United States, new industrial problems had presented themselves to the manufacturers, so that by the end of the summer it was impossible for the Phoenix Glass Company to consider our still incomplete order at the prices originally submitted. The price of labor in the glassworks has materially increased and, more serious than all, these companies are suffering a serious shortage of fuel. At the present time the government is allotting the supply of fuel in relation to the nature of the manufacturer's product. The glass companies, we are informed, will have their supply severely curtailed. Hence, for the present, we cannot be optimistic in obtaining for our Association an immediate source of supply of museum glass ware in America. On the other hand, we are fully convinced, that when industrial affairs again settle down to more normal conditions we shall have not only the interest, but the active co-operation of the local glass houses in fully supplying the needs of the Association. In fact we are still entertaining a hope that such an American source of supply may be obtained in the near future, and while the prices of articles manufactured

during the war-time, are sure to be relatively high, we will welcome it to meet our serious demands in the museums and the relation these bear to medical teaching.

Meantime, and shortly after the withdrawal of its offer by the Phoenix Glass Company a foreign source of supply was made known to us, which it was thought might be utilized to meet the present emergency for the convenience of those members urgently needing jars. An excellent sample jar was submitted by a New York firm with an announcement that such jars could be imported from an allied country at prices approximating those quoted by the Phoenix Glass Company. This firm desired, for commercial reasons, to withhold the name of the country in which the manufacture of these jars was located. It was pointed out to them, however, that it would be impossible to refer our members to them unless proof were given that the origin of these jars was not German, whereupon conclusive evidence was produced to the Secretary that the glass factory in question was located in Japan, and owned by Japanese. As Japan is a recognized Ally the address of this firm was sent on by the Secretary to the subscribers for their convenience, and a renewal order if desired was suggested. The offer made by this firm for jars imported from Japan at the original prices of the Phoenix Glass Company, was closed on December 20th last, the price of the manufacture having come up 30%. Moreover, the same serious drawbacks which surrounds all foreign importations at the present time, namely, delay in delivery, is an unsatisfactory factor in these arrangements, and we must still feel that a satisfactory solution of the problem of a source of supply of square glass museum jars remains in abeyance until the home manufacture can be achieved.

Signed: OSKAR KLOTZ, Chairman; M. E. ABBOTT, Secretary.

February 1st, 1917.

Postscript.—Since this Bulletin went to press we are informed from Japan that it is improbable that any orders can be filled. The home manufacture has, however, been taken up by the *Scientific Materials Company*, Pittsburgh, Pa., who offer an excellent jar, made in America, in six sizes, at a fairly moderate rate.

June 4th, 1918.

REPORT FROM THE MEETING OF COUNCIL OF THE AMERICAN AND CANADIAN SECTION OF THIS ASSOCIATION
HELD AT THE MEDICAL LABORATORIES, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, ON
MARCH 30, 1918.

Owing to War conditions, the annual meeting of this Section did not take place, but the usual Exhibit for the benefit of the members of the Association of American Pathologists and Bacteriologists, was held. Its chief features of interest were, a fine series of specimens from the Can-

adian National War Museum, mounted at the McGill Medical Museum, and shown by special permission of the Canadian Government; and a series of American made Square Glass Museum Jars, shown by the Scientific Materials Company, Pittsburgh, Pa., who had taken over the offer made by the Phoenix Glass Company, and were prepared to supply these jars but at a higher rate than previously offered.

A meeting of Council was held on March 30th at 2:00 p. m. at the University of Pennsylvania. Dr. O. Klotz was in the Chair, and Drs. Howard Karsner, R. A. Lambert, M. E. Abbott, and R. N. Pearce (by request) were also present.

The minutes of the last meeting were read and approved, and a financial statement showing an expenditure of \$252.08 and a balance of \$467.56 to the credit of the Association was submitted and accepted. A report upon the War Bulletin of the Association, in which form Bulletin VII. is about to be issued, was submitted by the Secretary, and it was decided to expend \$580.00 upon it, that being the amount available for this purpose in the Treasury on July 1st next.

A letter from Dr. F. F. Simpson, chief of the Council of National Defense at Washington, acknowledging the offer of the services of this Association to the American Government during the present War made by telegram at the close of the last meeting, was presented by the Secretary.

The resignation of Dr. A. S. Warthin from the active editorial work of the Bulletin was received, and a resolution was passed expressing the deep appreciation of the officers of this Association for the great interest which Dr. Warthin has shown in the Bulletin, and of the time and money which he has so generously spent upon it and which has done so much for its improvement and success, and the Secretary was instructed to send a copy of this resolution to Dr. Warthin.

It was decided to re-appoint the Secretary, Dr. M. E. Abbott, Editor, and to constitute Dr. A. S. Warthin and Dr. Howard Karsner an Advisory Editorial Board, with power to add to their numbers.

It was decided to accept the recommendation from Drs. Warthin and Abbott that the names of Dr. Carl V. Weller and Dr. Louis Gross be included with theirs as editors of the War Bulletin No. VII. on the ground of assistance rendered.

The following new members were elected: Miss Diana Blair, Harvard Medical School, Boston; Dr. Mark F. Boyd, University of Texas, Galveston; Dr. Arthur L. Groves, University of Southern California, Los Angeles; Dr. Wm. deB. MacNider, University of North Carolina, Chapel Hill, N. C., Major W. O. Owen, Army Medical Museum, Washington, D. C., Representative.

The officers were re-elected, with the exception of Dr. D. S. Lamb, resigned. Major W. O. Owen, Curator of the Army Medical Museum, Washington, was elected 3rd Vice-President in his place, and Professor R. M. Pearce was elected an additional member of Council.

Signed: MAUDE E. ABBOTT, Secretary.

Special War Retrospect

EDITED BY

Aldred Scott Warthin and Carl Vernon Weller

Ann Arbor, Michigan.

INDUSTRIAL POISONING IN MUNITION WORKERS.

ALICE HAMILTON, M.D., M.A.

Hull House, Chicago.

This article is a summary of the Report published as Bulletin, No. 219 of the United States Bureau of Labor Statistics, May, 1917, with additions from the literature up to date. For fuller information concerning industrial conditions attending the manufacture of explosives in this country the reader is referred to that report as in this paper it is intended to present concisely only the medical aspects of the various forms of industrial poisoning connected with munition making.

As a result of the European war the manufacture of munitions has become a very important industry in the United States. Its development has been feverish. Because of the necessity to fill contracts within certain specified time limits, haste has been the chief evil. This, with inadequate equipment, and the newness and unfamiliarity of this industry led to many accidents in the early months of development, and to many cases of industrial poisoning. The unskilled character of much of the labor employed, the general ignorance concerning the dangers involved, the lack of proper preventive methods, the dearth of medical inspectors and physicians familiar with these forms of occupational poisoning were all factors contributing to the occurrence of poisoning. Conditions are now improving, but unevenly and incompletely. Moreover, some of the dangers are inherent in the industry, and will always have to be guarded against, and it is inevitable that some cases of poisoning will occur. The poisons of which the physiological effects will be described are those that will be always encountered in this industry; and it is most important that superintendents, inspectors and physicians learn to

recognize their action and the means of prevention and protection of the laborers carried out in more experienced countries. Aside from their employment in the manufacture of explosives many of the poisons considered here have manifold uses in the arts and trades, and it is certain that their manufacture will continue in this country after the war is over and the manufacture of explosives is again reduced to a peace basis.

The development of munition making has taken place chiefly in the Eastern States, New Jersey leading in this respect. Forty-one factories employing 90,000 workers, 30,000 of whom were working in contact with poisons, were visited during 1916, in the preparation of this report. It is impossible to say how much industrial poisoning has already occurred among munition workers since the war began. The shifting labor, the general carelessness or indifference in some of the plants, the ignorance of the physicians in charge or their reluctance to give out information, etc., have made it impossible to give any estimate of the number of cases of poisoning or of the number of deaths resulting therefrom. In 28 plants in one year 2,507 cases with 53 deaths were recorded. The best managed plants having a good medical service and well-kept records, of course, show the largest number of cases, while the badly managed factories show few cases or none. From 13 plants no information could be obtained. Many cases were never recognized because of the fact that the physicians had no knowledge or experience of such conditions as cyanosis and syncope from nitrobenzol fumes, of oedema of the lungs from nitrous fumes, toxic hepatitis from TNT poisoning, etc. The chief object of this article is to summarize concisely the main medical features of these forms of industrial poisoning for the benefit of physicians engaged in or living near such industrial plants.

EXPLOSIVES, INVOLVING IN THEIR MANUFACTURE DANGEROUS
POISONS.

Ammonium nitrate.

Fulminate of mercury.

Nitrocellulose, nitrocotton, pyroxylin and military guncotton.

Nitroglycerin and dynamite.

Nitronaphthalenes.

Picric acid and ammonium picrate.

Tetranitraniline, TNA.

Tetranitromethylanilin or tetryl.

Trinitrotoluol, TNT, or triton.

POISONS USED IN THE MANUFACTURE OF EXPLOSIVES.

Acetone.
Alcohol.
Ammonia.
Amyl acetate.
Anilin oil.
Benzol, toluol or methyl benzol.
Caustic soda, sodium hydroxide.
Chile saltpeter, sodium nitrate.
Chlorbenzol and dinitrochlorbenzol, dimethylanilin.
Diphenylamine.
Dinitrophenol.
Ether.
Mercury.
Nitric acid.
Nitrobenzol.
Nitrogen oxide.
Phenol, carbolic acid.
Sulphuric acid.
Sulphuric ether.

POISONOUS BY-PRODUCTS IN MUNITIONS MANUFACTURE.

Chlorine gas. In making nitric acid.
Ethyl nitrite. In making mercury fulminate.
Oxides of nitrogen, nitrous fume. In nitration.
Sulphur dioxide. In making carbolic acid.

ACETONE.

Use:—Solvent for gun-cotton; in making smokeless powder.

Toxic Action:—Classed by Sommerfeld as an industrial poison; according to Kobert no cases have ever been reported. No American cases.

ALCOHOL.

Use:—In making smokeless powder to dehydrate and with ether to dissolve the cotton.

Toxic Action:—Fumes may be strong enough to cause drunkenness. More severe symptoms are produced by the combination of alcohol and ether, "ether gas." Alcohol aggravates the poisoning due to TNT, nitrobenzol, chlorbenzol, and other volatile poisons having an especial affinity for the cells of the central nervous system. Ether men are also more susceptible to the action of alcohol.

AMMONIA.

Use:—In the manufacture of ammonium nitrate.

Toxic Action:—Irritating and corrosive gas, producing inflammation of respiratory tract and pulmonary edema. Should not be used as an antidote for nitrous fumes, as condition is only aggravated.

AMMONIUM NITRATE.

Use:—In making dynamite and other mixed explosives.

Toxic Action:—Poisonous in large doses. Similar, but less depressant, in action to potassium nitrate. Believed by some to facilitate absorption through the skin and, thereby, to facilitate TNT poisoning.

AMYL ACETATE.

Use:—Solvent for gun-cotton in making smokeless powder.

Toxic Action:—Slight symptoms after exposure to atmosphere containing it, as inclination to cough, irritation of eyes and nose, dry, burning feeling in throat, slight feeling of weariness; in more severe cases there may be nervous symptoms, headache, sense of fulness in head, dizziness, nausea, numbness, palpitation, and disturbances of digestion.

ANILIN.

Use:—Used in the manufacture of diphenylamine for the explosive, tetryl, and for the rarer explosive, TNA.

Toxic Action:—Poisonous in small quantities, either inhaled or spilled on the skin. Mild cases are common in munitions-making; no fatal cases reported. Symptoms are cyanosis, methaemoglobinaemia, throbbing headache followed by dizziness, nervous symptoms, irritability, grouchiness, weakness, etc. Chronic cases develop severe anaemia, digestive, nutritional and nervous symptoms. Tumors of the bladder have a high rate of incidence in anilin workers. According to Brot the presence of a strongly levorotatory substance in the urine is one of the earliest signs of anilin poisoning.

BENZOL AND TOLUOL (METHYL BENZOL).

Use:—Benzol is used in the manufacture of phenol, and nitrobenzol; while toluol is used in large quantities in making the nitrotoluols, of which TNT is the most important.

Toxic Action:—Action of benzol and toluol are similar, although authorities disagree as to which is the more toxic. The symptoms following inhalation or absorption through the skin according to the degree of exposure and individual susceptibility. In mild cases there is a condition like early alcoholic intoxication with excitement and irritability, headache and dizziness, with later general malaise, loss of appetite and nausea. In the more severe cases there is dizziness, transient excitement quickly followed by stupor, twitchings, convulsions, loss of consciousness, cyanosis with respirations rapid at first, then slow, pulse rapid and temperature low. In slower cases there may be anaemia, haemorrhages from nose, lungs, gums and uterus, with a general purpura.

Autopsy findings:—Cyanosis, congestion of liver, spleen and kidneys, petechial haemorrhages into serous and mucous membranes and subcutaneous tissues, fat embolism, reddened and inflamed bronchi, small areas of interstitial emphysema in lungs, odor of benzol in lungs, diminution of white cells in blood, dilatation of right heart, loss of red marrow.

CHLORBENZOL, NITROCHLORBENZOL AND DINITROCHLORBENZOL.

Use:—By-products in munition making. Used chiefly in making anilin dyes. Absorption through skin, respiratory tract, and stomach.

Toxic Action:—Cause dermatitis, cyanosis, methaemoglobinaemia, fulness in head, throbbing frontal headache, nausea, dizziness, collapse, narcosis, death from respiratory paralysis. Blood is thick and chocolate colored. Urine dark, contains haematoporphyrin and hydrobilirubin. Dinitrochlorbenzol causes a more severe form of eczema than does picric acid. No constitutional symptoms reported in America as attributable to these substances.

CHLORINE GAS.

Use:—Chlorine gas is encountered in munition making on the charging floor of the nitric-acid building, developing from the sodium chlorid present in Chile Saltpeter.

Toxic Action:—Choking, asphyxiating fumes causing dyspnoea, soreness in chest, painful cough, asthmatic attacks, bronchitis, increasing air hunger, oedema of lungs, pneumonia. Death may occur from pulmonary oedema. In the severe cases haemoptysis and thromboses also occur. Death may occur later from obliterating bronchiolitis.

DIMETHYLANILIN.

Use:—Action of anilin on methyl alcohol and subsequent conversion to tetranitromethylanilin or tetryl (TNA).

Toxic Action:—A volatile poison, but the processes are carried on in closed receptacles and no cases of poisoning have been found as yet.

DINITROPHENOL.

Use:—In picric acid works. Nitration of phenol.

Toxic Action:—Warthin's case reported in this "Bulletin" is the first American case, although it is probable that some of the cases reported as picric acid poisoning were in reality due to dinitrophenol. Symptoms may be similar to those of dinitrobenzöl poisoning, formation of methaemoglobin, etc. In the case reported there was a fatal toxic jaundice, with marked degenerative changes in the liver, with multiple agglutination thrombi in the vessels.

DIPHENYLAMIN.

Use:—In making smokeless powder, dissolved in the ether-alcohol solution.

Toxic Action:—Similar to that of anilin. Combined with that of ether and alcohol as a mixed poison.

ETHER.

Use:—In making smokeless powder.

Toxic Action:—All stages of narcosis, "ether jag," from mild transitory symptoms to prolonged anaesthesia and death. Chronic poisoning affects the digestion and general nutrition chiefly. Degenerative changes may occur in heart, liver and kidneys, with chronic passive congestion and minute haemorrhages. Ether reduces the resistance of the body to bacterial invasion and to the action of toxins.

ETHYL NITRITE.

Use:—Given off in large quantities during the making of mercury fulminate by the action of ethyl alcohol on mercuric nitrate.

Toxic Action:—No serious poisoning reported. Headache, lassitude and feeling of weakness caused by it pass off quickly in fresh air.

MERCURY.

Use:—In the manufacture of fulminate. Danger of mercurial poisoning in workers who recover the mercury from the fulminate sludge.

Toxic Action:—Salivation, mercurial tremors in muscles of fingers, tongue and lips, nervous irritability, gastrointestinal disturbances, anaemia, nephritis and paralysis.

MERCURY FULMINATE.

Use:—Explosive; loading of caps, etc.

Toxic Action:—In itself not a dangerous poison. Causes a dermatitis of greater or less severity; and symptoms of a mild mercurialism. Marked individual susceptibility to the dermatitis. Eruption usually on hands and fingers, face and neck, but may involve the whole body.

MIXED NITRIC AND SULPHURIC ACIDS.

Use:—In manufacture of explosives. Used in nitration.

Toxic Action:—Fumes may cause pulmonary congestion, oedema, pneumonia and death.

NITRIC ACID.

Use:—The majority of explosives factories make their own nitric acid, and all recover it from waste. Nitric acid is made by the action of sulphuric acid on sodium nitrate. During the process oxide fumes may escape, or through the bursting of a pipe the acid may pour out with dense clouds of nitrous fumes.

Toxic Action:—See Nitrogen Oxide.

NITRO- AND AMIDO-DERIVATIVES OF THE BENZENE SERIES.

Use:—These play a more or less important part in the manufacture of explosives, particularly the following:—Nitrophenols, nitrobenzols, nitrotoluols, nitronaphthalenes, nitrochlorbenzols, amidobenzolanilin, diamidobenzol or diphenylamin, tetranitranilin and tetranitromethylanilin.

Toxic Action:—All of these poisons act on the blood and central nervous system. Some authorities claim that the nitro-compounds haemolyze the red cells, while the amido-derivatives produce methaemoglobin. Other writers find methaemoglobin produced by both. The toxicity increases with the degree of nitration, except when the lower nitrated products are more volatile than the higher, as is the case with mononitrochlorbenzol which is more dangerous than trinitrochlorbenzol. The more

volatile substances are more rapidly and acutely poisonous than the nonvolatile and sparingly soluble bodies, such as trinitrophenol (picric acid). The nitro and amido derivatives of the benzene series cause collapse and narcosis more rapidly than do the alcohols, for they act more decidedly on the vasomotor, respiratory and heat regulating centers. These effects are independent of the production of haemoglobin.

Symptoms of acute poisoning are:—Cyanosis, fulness in the head, frontal headache, loss of appetite, nausea, dyspnoea, small and rapid pulse, slowing of respirations, jaundice, unconsciousness, convulsions, death.

Chronic poisoning:—Anaemia, shortness of breath, headache, digestive disorders, disturbances of vision, hepatitis, toxic jaundice, atrophy or cirrhosis of liver, ascites, etc. Most of these substances cause more or less action on the skin, eczema, dermatitis. Picric acid, the nitrotoluols, tetranitranilin and tetryl stain the skin yellow, sometimes leading, to an incorrect diagnosis of jaundice or at other times masking a true jaundice.

NITROBENZOL (OIL OF MIRBANE).

Use:—Explosive. In this country is manufactured as a step in the production of anilin.

Toxic Action:—A dangerous volatile poison, easily absorbed through the skin, causing marked changes in the blood, and central nervous system. Its action is similar to that of anilin, but more rapid and intense, and is the cause of more deaths. (See preceding.)

NITROGEN OXIDE.

Use:—Given off as fumes during the process of nitration in making nitrocellulose or gun-cotton, picric acid, nitrotoluols, nitrobenzols, nitronaphthalenes, nitroglycerin and the nitric acid needed for these processes.

Toxic Action:—"Fume Sickness," irritating, corrosive gas causing congestion, necrosis of epithelium of respiratory tract, laryngitis, bronchitis, thrombosis in the capillaries of the lungs, pulmonary oedema, pneumonia, areas of emphysema, vasomotor dilation, haemolysis, bronchiolitis obliterans, etc. Symptoms in varying degree are those of choking, dyspnoea, increasing air-hunger, strangling, spasmodic cough, asthmatic attacks, burning and smarting in the chest, frothy, bloody sputum, epigastric distress, eructations of gas, vomiting, involuntary defecation, loss of consciousness, convulsions, death.

NITROGLYCERIN.

Use:—Explosive.

Toxic Action:—Nitroglycerin headache, an intense throbbing pain beginning in the forehead and spreading all over the head. Increased by stooping or lying down. Restlessness, insomnia, sometimes nausea and vomiting, and more rarely diarrhoea. Frequent urination, urine increased and of low specific gravity. A tolerance is rapidly produced, lasting as long as the man continues at the work. The headache may last 1-4 days. No dilatation of the blood vessels is seen in the old workers. Heart failure has been noted when the man suddenly quit the work and the loss of dilator effect of the drug made itself felt. Some writers believe the effects to be transitory and to leave no impairment of health. Ulcers and eruptions of the skin have been observed in men who mix and sift dynamite.

NITRONAPHTHALENES.

Use:—Nitration of naphthalene.

Toxic Action:—Less dangerous than the nitro derivatives of benzol and toluol. In mild cases of poisoning there is headache, malaise, nausea and vomiting; in the severer forms pains in the bladder, urethra and kidneys, degenerative changes in the retina, subretinal hemorrhages and cataract formation. Death may occur from nephritis.

PHENOL.

Use:—Chiefly in the production of picric acid.

Toxic Action:—Industrial poisoning takes place through the skin or lungs. Locally it has a corrosive action and may cause gangrene. When absorbed it causes quickening of pulse and respiration, then slowing, depression and weakness, dizziness, roaring in the ears, confusion, collapse with cold sweat, irregular pulse, respiratory failure and death. Chronic phenol poisoning is characterized by digestive disturbance, loss of appetite, complete anorexia, headache, anaemia, skin lesions, increasing marasmus and weakness, and chronic nephritis, from which death finally results. Pigmentation of the cartilages (ochronosis) may also result from slow chronic phenol poisoning.

PICRIC ACID.

Use:—Explosive. The nitration of phenol to make trinitrophenol or picric acid is an extremely dangerous process in the making of explosives because of the production of nitrous

fumes. This is the most serious danger, but both phenol and picric acid are also poisons.

Toxic Action:—Commonest symptom is picric acid “itch,” a dermatitis of varying severity, caused by picric acid dust. It is accompanied by burning and itching, usually on the exposed portions of the body, but may become general. There is also a systemic picric acid poisoning with symptoms similar to those produced by the other nitroaromatic compounds, but as picric acid is a solid and not volatile, the symptoms develop much more slowly and with less violence. Muscular weakness, irregular weak pulse, pallor with cyanosis, yellowishness of the skin, palpitation of the heart, headache, vertigo, mental confusion, nausea, dyspnoea, and in severe cases convulsions, methaemoglobinaemia and death. In Europe picric acid malingering has been observed in soldiers wishing to obtain sick leave. A small dose taken internally causes a condition of abdominal pains, vomiting, diarrhoea, yellowing of the skin and sclera, resembling acute jaundice, but differing from it in that there are no clay-colored stools. True jaundice may, however, be produced by picric acid, as it is by dinitrophenol. It is also possible that some of the fatal cases of supposed picric acid poisoning were in reality poisoning by dinitrophenol. Chronic picric acid poisoning is characterized by gastroenteritis, abdominal cramps, vomiting, diarrhoea, bitter taste, catarrh of nose, throat and bronchi, loss of weight and strength.

SULPHUR DIOXIDE.

Use:—Fumes of sulphur dioxide are given off at a certain stage in the manufacture of sulphuric acid and in the production of phenol.

Toxic Action:—Similar to that of nitrogen oxide fumes. Is irritant even when present in very small amount in the air. Causes inflammation of the bronchi, bloody sputum, dyspnoea, congestion, oedema and inflammation of the lungs. May be rapidly fatal.

The fumes of sulphur trioxide are also irritating but less dangerous than the dioxide.

TETRANITRANILIN (TNA).

Use:—Is but little used in this country.

Toxic Action:—Only local effects observed here. Action of dye on hair and skin.

TETRANITROMETHYLANILIN (TETRYL).

Use:—Explosive. Detonator.

Toxic Action:—Chief effect an obstinate dermatitis. Mild cases show roughening and itching of the skin of the hands. Severe cases may have oedema of the face, eyelids swollen shut. Mild conjunctivitis and nasal irritation, watery discharge, sneezing and nose bleed. Slight constitutional symptoms as headache, drowsiness and loss of appetite. Cessation of menstruation from 1-3 months has also been noted. It has also been stated that tetryl dermatitis appears on the chin, nostrils and eyelids while TNT lesions are most pronounced on hands and arms.

TRINITROTOLUOL (TOLUOL, TRITON, TROTYL, TNT).

Use:—Explosive.

Toxic Action:—Next to nitrogen oxide this substance has been responsible for more cases of industrial poisoning in munition workers than any other one. The inhalation of TNT dust causes burning in the throat and nose, with abundant secretion, like a severe cold, with a sense of tightness in the chest and an obstinate cough. A distaste for food, bitter taste in the mouth, and nausea may be the first symptoms. Vomiting, headache, lividity, cyanosis, jaundice, dizziness, coma, convulsions, fever, delirium and death characterize the severe cases. The pathological findings are those of acute yellow atrophy of the liver, a toxic hepatitis with icterus, toxic degenerative nephritis, haemolysis, anaemia, cloudy swelling of the myocardium, petechial haemorrhages, etc. The liver cells show extreme fatty degeneration, necrosis and autolysis, involving particularly the central and intermediate zones of the lobules. When poisoning occurs immediately from large doses of TNT the symptoms are more like those produced by the nitro derivatives of the benzene series. These cases are less typical than the toxic jaundice cases. Death may be due to oedema of the lungs, hemolysis, asphyxia, etc. TNT has also an irritating effect upon the skin caused more by dust than by fumes. The lesions show great variation in type and severity. There are marked individual susceptibilities. There are conflicting views as to the development of an immunity. British writers distinguish two groups of TNT poisoning, the *irritative* and the *toxic*. Under the first group they class respiratory, gastric and skin cases: under the toxic; digestive, circulatory, cerebral and special cases. The toxic cases are usually slow

but may be fulminating. There seems to be no relation between the severity of the symptoms and the outcome of the case. (See also Dr. Haythorn's article on TNT poisoning.)

For the industrial conditions in American munition factories, methods of prevention and treatment, industrial laws, etc., the reader is referred to Bulletin 219 of the U. S. Department of Labor Statistics.

INDUSTRIAL POISONING IN AIRCRAFT WORKERS.

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The occurrence of industrial poisoning ("dope poisoning") in workers engaged in aeroplane manufacture is due to the use of various volatile poisonous solutions ("dope") of cellulose acetate or cellulose nitrate in the varnishing or waterproofing of the cloth covering the planes. The vapour of the "dope" is heavier than air, and collects near the floor. Exposure to "dope" fumes is the immediate cause of the poisoning. Conditions favoring the occurrence of "dope poisoning" are poor ventilation, carelessness, hot weather, accidental spilling of the "dope", and similar factors favoring the absorption of the volatile "dope" through the respiratory or intestinal tract. The volatile solvents of cellulose acetate and cellulose nitrate are tetrachlorethane, acetone and other ketones, various alcohols, benzene, and amyl acetate. For the training planes nitrate "dope" is used; but as it is inflammable the war planes are treated with the non-inflammable cellulose acetate. At the beginning of the war tetrachlorethane "dope" was used in Germany and England, but the occurrence of fatal cases of poisoning from its employment led to recommendations against its use, both in Germany and England. We do not know what methods of prevention have been carried out in Germany, but in England toxic jaundice from aeroplane "dope" was made a reportable disease in February, 1916, and brought under the workmen's compensation act. By August, 1916, "dopes" free from tetrachlorethane were employed, and it is no longer used in British aeroplane manufacture. In the manufacture of war planes in this country our Signal Corps has advocated a "dope" of cellulose acetate dissolved in acetone, alcohol and benzene, or the acetone may be replaced by a mixture of methyl alcohol, methyl acetate and acetone. The dangerous tetra-

chlorethane "dope" which has been used in some of our airplane factories has given rise to some cases of mild intoxication. No fatal jaundice has been reported. It will gradually be replaced by other forms of "dope" in which solvents will be benzene, methyl alcohol, acetone and other ketones, amyl acetate and perhaps amyl alcohol. These are all volatile substances capable of producing industrial poisoning through absorption through respiratory or gastrointestinal tracts. They differ greatly in toxicity however. Our "dopers" will be exposed to the fumes of these rather than to the more dangerous tetrachlorethane so that the toxic jaundice of aeroplane workers observed in Germany and England will probably not occur here except as a rare thing. Nevertheless both benzene and methyl alcohol are important dangerous industrial poisons; the other solvents that may be used are less well known and probably much less dangerous. Federal and state authorities should follow the example of the English in the regulation of "doping" rooms as to ventilation, etc., regular medical examination of "dopers", reporting of cases, etc.

TETRACHLORETHANE.

According to Lehmann air containing no more than 1 or 2 mg. of tetrachlorethane to a liter can be breathed for a relatively long period—six to seven hours a day for eighteen days spaced over four weeks—with no more serious results than loss of weight and drowsiness. When the fumes are stronger narcosis results, and after repeated exposures there are serious disturbances of metabolism. In fatal cases he found hemolysis, basophilia, fatty liver and heart, and congestion of the kidneys. He regarded tetrachlorethane as the most poisonous of the chlorin derivatives of the hydrocarbons, four times as poisonous as chloroform and nine times as much so as carbon tetrachlorid (tetrachlormethane).

Jungfer in 1914 reported four cases of severe poisoning in four out of eight aeroplane "dopers", one case being fatal. Later in another factory in the same place (Johannisthal) ten men were poisoned and one died. Grimm, shortly after was able to give the details of fifteen cases of poisoning in aircraft "dopers". Heffter and Joachimoglu examined the "dope" fluids, and found the toxic constituent to be tetrachlorethane. Experimenting on dogs they found that the commercial mixtures and pure tetrachlorethane when rubbed into the skin or inhaled caused loss of weight, narcosis, vomiting, presence of blood and bile in the

urine, and death with fatty degeneration of the liver, and haemorrhages into the mucous and serous membranes and heart muscle. In the inhalation experiments a gradually increasing tolerance, as far as the production of narcosis is concerned, was observed, but the end results were the same. The last available German report on "dope" poisoning is that of Koelsch in 1915. He made a study of industrial tetrachlorethane poisoning, and divided the cases into two classes: (1) those with pronounced gastrointestinal symptoms, nausea, vomiting, cramps, enlarged liver and jaundice; (2) those with little or no abdominal disturbance, but with nervous symptoms, headache, paraesthesias, tremors, disturbed reflexes and slight paralyses. Two cases in the first class had been diagnosed as lead colic.

The first case of tetrachlorethane poisoning in England occurred in October, 1914, in a "doper" in an aeroplane factory in Hendon. He had developed jaundice after working eleven weeks and died after three weeks illness. His liver was small and green in color. Investigation of the other "dopers" by Legge, chief medical inspector of the factories revealed ten cases showing signs of hepatitis. All had gastric symptoms and jaundice, and had worked from three to sixteen weeks before becoming ill. The mild cases showed only headache, drowsiness, disagreeable taste in mouth, loss of appetite and constipation. In the severe cases jaundice, pain in epigastrium, vomiting of blood, convulsions, suppression of urine and coma may be followed by death. Badly nourished workers succumb more readily than others. By February, 1916, forty-three cases with seven deaths, had been reported. Wilcox found tetrachlorethane to be the cause of these cases of "dope" poisoning, although the "dopes" used also contained benzene, methyl alcohol and acetone in addition to the tetrachlorethane. The "dopes" known as *emallite*, *titanine*, and *cellon* contained 11-12 per cent of tetrachlorethane, other "dopes" had even higher percentages.

Owing to the conditions attending the development of airplane manufacture in the United States no deaths from tetrachlorethane "dope" have yet been reported, although cases of milder poisoning (drowsiness, dizziness, fainting, nausea, headache, resembling alcoholic intoxication), and one case of slight jaundice have occurred. Should tetrachlorethane "dope" continue in use the development of the industry may yield more severe cases of this form of industrial poisoning, if suitable precautions are not taken.

The distinctive features of fatal tetrachlorethane poisoning are a degenerative hepatitis and haematogenous jaundice of a slow and insidious onset, marked fatty degeneration of liver and heart muscle, and cloudy swelling and fatty degeneration of the kidney epithelium. It somewhat resembles delayed chloroform poisoning, but the jaundice is usually deeper. Tetrachlorethane is seven times as hemolytic for mammalian blood as is chloroform. The duration of the disease is longer than in acute yellow atrophy. From Weil's disease (infectious jaundice) it is distinguished by the absence of marked fever. The degree of anemia is less than that found in arsenical jaundice. Oliver says there is no anemia and no hemolysis. He regards the jaundice as obstructive in type from the catarrhal condition of the bile passages.

BENZENE.

This is the most toxic of the solvents employed in the "dopes" advocated to take the place of the tetrachlorethane "dopes". It forms about 12-15 per cent of the "dopes" in use. Severe acute poisoning will probably not occur, but the lighter forms, dizziness, headache, transient excitement like drunkenness, followed by depression and nausea—the so-called "naphtha jag"—may be expected. Chronic benzene poisoning may also be expected when conditions of labor are bad, and the workers unprotected. The symptoms of chronic poisoning are pains in muscles and joints, tenderness on pressure, weakness and coldness of the right hand, psychic depression, loss of memory, difficult speech, increased excitability of the skin to mechanical irritants and heightened tendon reflexes.

AMYL ACETATE.

Because of the disagreeable character of the "banana oil" many workmen and foremen become prejudiced against the use of amyl acetate and believe it to be more poisonous than tetrachlorethane, and sometimes on this account the latter "dope" is substituted for it. Although it is disagreeable and causes smarting of the eyes and sometimes conjunctivitis, and dry throat and an irritating cough, dizziness, drowsiness and weariness it is much less dangerous than tetrachlorethane "dope". Experiments on animals give transient reactions, except after very long exposures (237-340 days, Koelsch) when death with fatty liver,

pulmonary oedema and areas of pneumonia were found. It is, therefore, possible that long exposure to it may produce visceral lesions, especially in the liver.

AMYL ALCOHOL.

According to Salant amyl alcohol (fusel oil) is seven times as toxic for frogs as ethyl alcohol, and four times as much so for rabbits. When inhaled as a vapour it produces vertigo, headache, ringing in the ears, faintness, lowering of blood pressure, nausea and vomiting. It is more rapid and severe in its effects than ethyl alcohol and causes a more decided fall of blood pressure.

METHYL ALCOHOL.

The toxicity of this substance is still a matter of dispute. Reid Hunt's experiments show that pure methyl alcohol produces all the characteristic symptoms of wood alcohol poisoning, and that they are not to be attributed to the impurities only. We do not, however, know in what proportion it is dangerous. Our denatured alcohol contains 4 per cent and this is assumed to be well within the danger limit. Robinson has, however, just reported a case of blindness from the industrial use of a 4 per cent wood alcohol solution (colorite). The German denatured spirit contains only 2 per cent, but its industrial use has caused so much illness among workmen that, according to Goldschmidt, petitions have been sent to both the Reichstag and the Bundesrath for an inquiry into its harmfulness. There is apparently a great individual variation in susceptibility to the action of methyl alcohol. The serious action upon the eye makes industrial poisoning from this source especially to be dreaded. Acute poisoning from methyl alcohol, when inhaled or swallowed, is characterized by abdominal cramps, thirst, coryza, nausea and vomiting, vertigo, headache, chilliness, muscular weakness, dilatation and immobility of the pupils with visual disorder, dyspnoea, restlessness and insomnia. The fatal cases show cold sweats, delirium, coma and apnoea. In fatal cases granular degeneration of the retinal ganglion cells with swelling in the fibrils of the optic nerve have been noted. Aside from the ocular changes no other definite pathological changes have been observed. The blindness usually develops within 12-24 hours after exposure to the fumes of wood alcohol. Death may follow within one to two days from cardiac paralysis. The symptoms may be slow in developing, but are rapidly cumulative after the onset. The apparent immunity of

some individuals to the action of wood alcohol has been explained as the result of a failure to oxidize it. Chronic methyl alcohol poisoning in varnishers is characterized by conjunctivitis, epiphora, amblyopia and persistent photophobia, hyperaesthesias and paraesthesias and motor weakness of the arms, paroxysmal pains and tenderness on pressure over the nerves. Artificial respiration, cardiac stimulants hypodermatically and transfusions of blood or salt solution are recommended therapeutically.

ACETONE.

According to our present knowledge acetone is harmless; but the question cannot be regarded as settled, as very little work has been done upon it.

CONCLUSION.

The use of tetrachlorethane "dope" should be prohibited, as in England; and "doping" rooms should be given proper ventilating methods, down-draft, etc., as required at the present time in England. Further, regular factory inspection and medical examination of the "dopers" should be carried out.

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THE PATHOLOGY OF TRINITROTOLUENE POISONING.

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Trinitrotoluene poisoning has become an exceedingly important occupational disease since the beginning of the present war. It is important because of the great number of employees of munition factories brought in daily contact with it and thus exposed to its toxic influence, and because a thorough knowledge of its various paths of entrance into the body and of the many ways in which its toxic effects may be manifested is essential, before efficient measures for its prevention can be carried out. Dr. W. J. O'Donovan (1) of the British Ministry of Munition in discussing it said in part, "the problem * * * is not mainly one of clinical symptoms and diagnosis but is the largest problem of preventive medicine that has yet arisen from any manufacturing process."

The explosive is known under the names of Trinitrotoluene, Trinitrotoluol, Trotyl and TNT. It is made by nitrating toluene, which is a coal tar product. Toluene is a benzene compound having one hydrogen atom replaced by a CH_3 group and in the nitrating process three more hydrogen atoms are replaced by NO_2 groups so that the formula for Trinitrotoluene is $\text{C}_6\text{H}_2(\text{NO}_2)_3\text{CH}_3$. It is a powder at ordinary temperatures which becomes fine and dusty on drying and is of a pale yellowish-tan color. For handling, shipping, etc., it is kept moist and appears as a rather coarse flaked crystalline substance not unlike yellow cornmeal in appearance. It is volatile, always possessing a slight odor at ordinary temperatures and it gives off clouds of yellow fumes when subjected to temperatures between 80°C and 140°C . It melts at about 80°C and becomes a molasses-like fluid which on cooling forms a yellowish crystalline solid cake. If heated above 140° it ignites, and, if free, burns with a hissing flame and gives forth a tremendous volume of black smoke and soot. The powder has a bitter taste, is insoluble in water, and soluble in alcohol, ether, acetone, benzine, xylol and in many greases and oils. It has the property of staining cloth a permanent yellow. It stains the skin of workers a pale yellow tint so that they are sometimes called "canaries" (10) by their fellow workmen. The fumes sublime in the form of fine glistening particles when coming in contact with objects at ordinary tem-

peratures. This sublimate is of different chemical nature and is known as amatol. When placed under pressure and heated to nearly 140° and set off with a fulminate of mercury cap it explodes with great violence. Tests show that steel bombs can be blown by it into more than 1200 pieces (10).

The history of trinitrotoluene poisoning begins with the present war and while short in the point of time is even now quite comprehensive. The British Ministry of Munitions (15) in their 1916 report cite a case of "Acute Yellow Atrophy of the Liver" occurring in 1906 in a dinitro-benzol worker, and Wilcox (11) reported an epidemic of Toxic Jaundice due to tetrachlorethane poisoning with an autopsy by Spillsbury in which acute yellow atrophy of the liver was found. In May, 1916, Spillsbury (12) demonstrated a case of acute yellow atrophy of the liver from a trinitrotoluene worker. In August, 1916, Livingston-Learmonth and Cunningham (13) made their comprehensive report of the clinical findings in TNT. poisoning among women workers in British Munition factories and reported an autopsy with the findings of acute yellow atrophy of the liver. Martlandt (14) appears to have been the first to report autopsies on TNT. poisonings in the United States. For a more complete knowledge of the history of TNT. poisoning the reader is referred especially to:—The Report of the British Ministry of Munitions on "The Prevention of TNT. Poisoning (15), the Proceedings of the Royal Society of Medicine (Jan., 1917); to the Articles of Dr. Alice Hamilton (16, 17, 18) and to the more recent article by Panton (20).

It is impossible to get a dependable record of the occurrence of Trinitrotoluene poisoning because the workers are a transient lot and the number of employees at any one time gives no idea of the total number for any one month or year. Dr. Hamilton (16) mentioned in one article (May, 1916) that there were about 30,000 employees working in the forty-one munition factories in the United States and that she had on her list at that time 703 cases of TNT. poisoning with 33 deaths. The Royal Society Report (7) gives for the year of 1916 a total of 181 cases of "Toxic Jaundice" alone due to TNT. with 52 deaths. There is a great variation in individual susceptibility, and a great majority of workers develop a tolerance for dust and fumes. The number of susceptible persons decreases where hygienic measures are adopted by both employers and employees. On the other hand there is undoubtedly a cumulative action of the poison

in toxic jaundice, as most of the cases of toxic jaundice appear during the third month of employment. Alcoholism has been claimed by some and denied by others to be a predisposing cause. Dr. F. W. Matthewson (27) who is in medical charge of the employees of one munition works, says that the negro employees stand the dust and fumes much better than whites. Young persons are far more prone to develop toxic jaundice than those between the ages of thirty and fifty years.

PATHS OF ENTRANCE.

The poison enters the body in at least three ways. I. Through the skin; II. by inhalation, of dust, fumes or both; III. by being swallowed and absorbed along the intestinal tract. The discussion as to the chief mode of entrance is interesting and important from the standpoint of prevention.

I. More (2) believes that the absorption of TNT. by the skin is the only important consideration, he reported that after rubbing his hands in TNT. and immediately washing he was able to get a positive Webster's test for combined TNT. in his urine which remained positive for ten days. He stated that this experiment was less successful when tried on his assistants and suggested that this individual difference in the permeability of the skin may explain the great variation in the susceptibility of individuals to poisoning. I have several times rubbed considerable quantities of TNT. on my forearms and allowed it to remain until the skin became slightly stained and erythematous. I used rubber gloves during the rubbing, to prevent contamination of the tests from my hands and have not been able to get a positive Webster's test in my urine, at any time. I also produced dermatitis in a guinea pig by inunction with TNT. I was unable to collect a urine sample during life which was not contaminated from loose hairs, but the sample aspirated from the bladder at autopsy was negative and this notwithstanding the fact that the subcutaneous fat beneath the lesion was stained a deep orange yellow.

II. Most of the data in favor of inhalation as the chief route of entrance consist in the large number of individuals who are exposed to fumes and who develop toxic symptoms. More spent twelve hours in a factory collecting the dust and fumes in an inhaler at twice the rate of ordinary breathing and only collected between five and six milligrams of the poison. He took several times that amount internally without untoward effects.

He exposed animals for nine months in fumes and dust at the Woolwich Arsenal and they did not become ill, but "thrived and bore healthy off-spring". He did not state what animals were used but from my own former experiments in which I attempted to cause anthracosis in guinea pigs and rabbits by the inhalation of very fine lamp black, I found that the turbinate bones were so tortuous that few solid particles could be made to pass them. I have also exposed guinea pigs to heavy TNT. fumes without producing poisoning, but I do not think any of the experiments so far are conclusive. Another factor may be found in the acute gassings which are fairly common during the nitrating process and it may be that the hot fumes produce an inflamed and denuded condition which makes the membranes of the air passages far more permeable than normally.

III. The intestinal route is to say the least an important one. Considerable quantities of TNT. are swallowed with the saliva, taken in with the foods, and with chewing tobacco. The poison has been recovered from the stools and from vomitus and the irritation symptoms of the gastro-intestinal tract are in themselves suggestive. I produced poisoning in two guinea pigs by feeding in the following way: With the animal on its back, the flaked form of TNT. was placed far back in the throat and a small quantity of milk or water given with a dropper, the nostrils being held shut until the animal swallowed. One animal died after three doses of about one gram. At autopsy the heart was dilated, the stomach and colon distended and partially filled with reddish material, which gave Webster's TNT. test. Microscopically, the liver cells contained granular fat and a peculiar vacuolation about the cell nuclei. The urinary bladder was filled with a brownish-red urine which was negative to potassium hydroxide and alcohol before being treated with acid and became positive after treatment. The bile was aspirated from the gall bladder with a syringe and gave a positive Webster's test after treatment with acid. The other animal was given eight doses extending over eleven days. He lost weight and toward the last showed severe toxic symptoms. At autopsy the chief findings were a generalized orange-brown staining of all of the organs and of the fat, and a brownish colored liver with many small whitish-yellow points interspersed with a few larger areas of whitish-yellow necrotic tissue. The gall bladder was almost empty and the bile gave a negative test for TNT. after Webster's method. The urine, stomach and rectal contents gave pos-

itive tests. Extracts of the organs were negative. The sections of liver showed circumscribed areas of necrotic lobular tissue, the location of which was generally but not always near a central vein. The cells about these areas showed large fat vacuoles. The necrotic areas contained a few large brown pigment bearing endothelial cells and a considerable number of polymorphonuclear leucocytes.

It is certain from these two successful experiments that TNT. may enter the body by way of the intestinal tract and that it may also affect the liver through this route.

SYMPTOMS.

The many clinical manifestations have been so thoroughly and frequently described that they will receive only the merest mention here. One class of symptoms called "minor poisoning" symptoms are most frequently seen in beginners and often disappear as some tolerance is acquired; they are said to consist of dizziness, drowsiness, mild frontal headache, loss of appetite and diarrhoea or constipation. In the more toxic forms swelling of hands and feet, bradycardia, cyanosis of the mucous membranes, dyspnoea, vomiting, very severe jaundice, distention, constipation, muscle pains and choluria may develop and may finally terminate in either acute yellow atrophy of the liver or in aplastic anaemia. Choluria is especially emphasized as an important prodromal symptom of toxic hepatitis. The more acute gassings depend on the inhalation of a relatively large amount of fumes or gas. The victim may be rapidly overcome and lose consciousness or become dyspnoeic, cyanosed and gasp for breath. Fresh air, artificial respiration and aromatic spirits of ammonia under pressure, are used to restore these patients and a few days' rest is generally sufficient for their complete recovery. Edema of the lungs, hemorrhages and secondary pyogenic infections have sometimes followed. Another very common form of poisoning is shown in the skin lesions. These were quite fully described by Livingston-Learmonth and Cunningham (13), White (19), Smith (21), and others, and consist of several forms of dermatitis.

DERMATITIS.

The skin lesions vary from the simple yellowish staining of the skin which cannot be washed off with ordinary simple scrubbing to severe inflammation with desquamation and fissuring.

The changes are due to the direct irritation of TNT., to which may be added infection and chaffing. The hands, arms and parts of the body which do not receive the protection of the clothing and the more sweaty portions of the body are commonly affected. Additional irritation of the clothing such as rubbing and scratching tends to aid the toxic action. White (19) mentioned that he had personally seen between forty and fifty cases of dermatitis and gave a detailed description of several of them. The process appears to begin with a simple reddening and varies greatly with individual instances. Papular and vesicular stages are common, crusting and peeling usually follow and where the patient is exposed to the weather deep fissures have been known to develop. Simple dressings and removal of the cause generally brings early recovery.

A severe dermatitis was produced on the back and neck of a guinea pig by inunction with TNT. in oil. The skin became swollen, thickened and thrown up in rugae; the hair fell out and a fine mealy desquamation took place. Notwithstanding the fact that the lesion was so situated that the animal could not scratch it, it developed relatively large irregular crusts. The skin and subcutaneous tissue were removed at autopsy. The general appearance of the skin resembled that of a mild burn and the subcutaneous tissues were stained a deep orange yellow. Histologically, the stratum corneum was thinned out and broken in places; the crusts were superficial and did not reach below the epidermis. The Malpighian layer was edematous, the fixed cells being swollen and infiltrated with a few polymorphonuclear leucocytes. Between the Malpighian layer and the papillae were spaces filled with serum and infiltrated with cells; the papillae and deep connective tissue fibers of the corium were edematous, the collagen fibrils were swollen and the spaces between them were infiltrated with leucocytes, many of which were flattened out and appeared somewhat spindle-shaped from pressure. A few plasma cells were also present. The infiltration was quite profuse around the ducts of the sweat glands and hair follicles.

BLOOD CHANGES.

M. J. Stewart reported on the repeated examinations of the blood from fourteen patients admitted for TNT. poisoning to the Leeds General Infirmary. One only, showed a normal blood; nine showed a polymorphonuclear leucopenia; nine an absolute lymphocytosis; three the picture of pernicious anaemia save for

the absence of poikilocytes and punctate basophilia; and one showed a progressive neutrophil leucocytosis just prior to death. Dr. Pantón (4) examined the blood of fifty women employees of a TNT. factory. He found a leucocytosis above ten thousand in a majority of those who had been employed for more than a month. He also reported four cases of severe anaemia of the aplastic type. These were severe anaemias, with a high color index, without nucleated red cells or poikilocytes, and showed an extreme leukopenia with a relative lymphocytosis. He cited one case as having a count of 1,637,000 red blood cells; haemoglobin of 35 per cent with a color index of, 1.1; white cells 1,400 per c. mm. of which there were neutrophils 20 per cent, lymphocytes 77 per cent and large hyalines three per cent. In a later article Pantón (20) gave the average counts made on employees at work as being red cells from five to six million with haemoglobin estimations varying from 86.1 to 90 per cent. He reported a case of purpura in a girl aged twenty-one who had been employed seven weeks in a TNT. factory and who had quit work two weeks before she became ill. She developed bleeding from the vagina, mouth and rectum ten days before death, and later had a generalized purpuric rash. Her red count was 1,200,000; white cells 480 per c. mm.; haemoglobin 8 per cent; color index 0.3. She had seventy-five per cent lymphocytes. The coagulation time was four minutes. At autopsy the vertebral marrow was grey and the red marrow decreased greatly in amount. Pantón is responsible for the statement that TNT. poisoning has no effect on the value of a Wassermann reaction.

PATHIOLOGY.

A study of the autopsy records which have been reported brings out the fact that there are two separate, and so far as has yet been shown, two distinct classes of poisonings due to the action of Trinitrotoluene. I. The *Toxic Jaundice* cases associated with acute yellow atrophy of the liver, and II. The *Anaemic* cases which are of the aplastic type and are often associated with purpuric conditions. The case which I am reporting belonged to the Group I.

CASE REPORT.

G. J. Male. Aged 24. Had been employed as a TNT. packer from July 30th to Sept. 16th, when he went to work for another branch of the same company. On Oct. 14, he applied

to Dr. F. W. Matthewson, the physician for the company, and gave the history of having inhaled a large amount of fumes in the drying room the day before he left the place where he was first employed. He said that he had been ill since that time. He was referred to the service of Dr. McKelvy of the Allegheny General Hospital with a diagnosis of T. N. T. poisoning and probable atrophy of the liver. The following synopsis was taken from the record of the examination which was made at the hospital by Dr. C. C. Hartman.

The patient was found lying in bed in a comatose condition with labored breathing, slight general cyanosis and yellow icteric tint to the skin everywhere. The skin was warm and bathed in perspiration, no purpuric spots were found. There was dried, brownish blood-like material about the nares. The teeth were poor, some being old carious stumps. The tongue was dry, covered with bloody material. The mucous membranes were cyanotic. Respiration was rapid—44 per minute. The accessory muscles were in use and there was both inspiratory and expiratory rattling in the throat. Great numbers of dry, crackling and moist bubbling rales were found all over the front and back of the chest but no consolidation was made out. The heart was normal in size and the sounds were obscured by the loud rales in the chest. The pulse beat was 150 per minute, of small volume and somewhat irregular. The abdomen was scaphoid in appearance, the abdominal wall was rigid and the presence of tenderness was not demonstrable. No ascites was present. The liver dulness extended from the sixth rib to the costal margin and the edge of the liver was not palpable. The extremities were relaxed and no edema was present. A blood count was made at once, the red cells were found to number 6,640,000; the white blood cells 10,700; and haemoglobin 115 per cent by Sahli's method. The differential count of 300 cells showed 84 per cent polymorphonuclear leucocytes, 10 per cent lymphocytes, and 3 per cent large mononuclears as the important findings.

AUTOPSY.

The autopsy was done by Dr. C. B. Schildecker, coroner's physician, on the embalmed body, thirty-six hours after death.

SYNOPSIS OF AUTOPSY PROTOCOL.*—The body was that of a tall, well developed and moderately well nourished white male. The skin over the entire body and the sclera was extremely yellow. The subcutaneous fat was orange yellow. Petechiae were present over the pleural surfaces of the lower lobes of both lungs. The left lung was extremely congested and contained some bright red solid portions together with much fluid. The greater portion of the right lower lobe was more or less consolidated though it floated when placed in water. The lung showed a large calcified area due to healed tuberculosis. The solid portions appeared to be haemorrhagic and were of a purplish-red color. The epicardium presented numerous bright red petechiae. The heart was dilated but other changes were masked by the effects of the embalming fluid. The liver was small and there were numerous adhesions about the under surface. The right lobe which appeared to make up more than two-thirds of the liver was removed for examination. It weighed 655 grams and from this the weight of the liver was estimated to be not more than 970 grams. The left lobe was uniformly bright red in color. The greater portion of the right lobe, too, was replaced by a bright red soggy tissue. Near the central portion of the lobe, lobules of yellowish liver tissue, sometimes mottled with red, were found. At the extreme posterior portion of the liver fairly well preserved lobules could be made out distinctly. These were separated by brownish-red lines and showed small brownish points near their centers. Much bloody material could be squeezed from the tissues. The gall bladder was contracted and contained some greyish pyoid material and some inspissated bile. After washing, the mucosa was found to be injected and inflamed. The pancreas was negative. The kidneys were enlarged, measuring $15 \times 6 \times 4\frac{1}{2}$ cm.; the capsules stripped easily leaving a reddish-brown surface; the cortex was thickened and of a light yellowish-tan color; the pyramids stood out prominently as bright red islands.

Microscopic Changes. The intermuscular connective tissue spaces of the heart were infiltrated with fat. All of the muscle cells stained bright red with Sudan III showing fat of a finely granular type. The bronchi were desquamated and showed peri-

*Prepared from my own notes made immediately following the autopsy, which I witnessed, and from the subsequent examination of the gross specimens referred to me for microscopic examination.

bronchial infiltration. Entire lobules of the lung were hemorrhagic, the alveolar walls showed coagulation necrosis and many of the areas were bordered by masses of golden pigment bearing cells. Smaller foci of hemorrhage and areas of bronchopneumonia were present. No thrombi or other vascular changes could be found in any of the sections, which was accepted as evidence that the extravasations were of haemorrhagic nature rather than that they were infarcts. The spleen presented nothing more than congestion and hyaline degeneration of the follicles. The areas of Langerhans in the pancreas appeared lobulated as if undergoing hyperplasia and were large and cellular. The kidney glomeruli were swollen, contained serum and some of the lining endothelial cells stained positively for fat. There was extreme fatty infiltration of the epithelial cells lining all of the tubules. It was most marked in the convoluted tubules and occurred to a slightly lesser extent in the straight tubules. The kidney vessels showed no obvious changes.

Microscopic Changes in the Liver deserve a more careful description. Sections from the red areas showed a complete absence of liver cells. The bile ducts remained intact but showed no evidences of regeneration. The connective tissue stroma remained unbroken as did also the capillaries. The sinusoidal spaces contained large phagocytic cells which were filled with brown pigment. The pigment cells in these areas gave a negative test for hemosiderin and a few of them contained stainable fat. Many lymphocytes and infiltrating plasma cells were present. Sections taken from areas where only small islands of recognizable liver cells remained showed them to be for the most part small and filled with bile pigment, which was also occasionally present in the form of casts in the bile capillaries between the cells. (See Fig. 1.) These cells showed little or no fat with osmic acid, Sudan III or Nile blue stains. Sections from the best appearing areas of liver tissue generally showed one-third or more of the lobule about the central vein to be devoid of liver cells, the spaces left by them being filled with red blood cells and great numbers of phagocytic endothelial cells filled with pigment. (See Fig. 2.) These cells continued chiefly bile pigment but fine fat granules were also present as could be seen in the Nile-blue-sulphate preparations. Occasional phagocytes showed a few blue granules after the iron test was done. The mid-zonal portions of the lobules were made up of swollen liver cells which were full of fine bile pigment and fat granules. The stains for fat showed

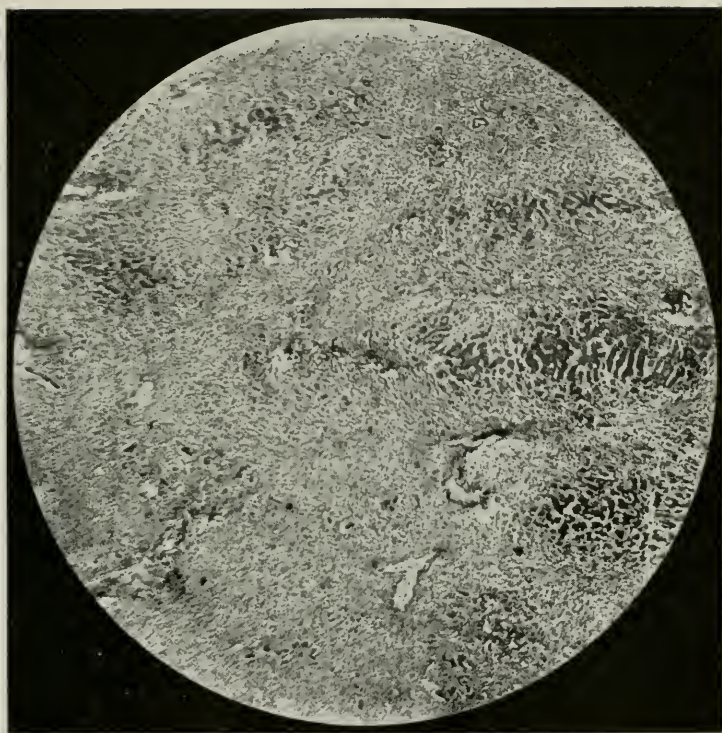


FIG. 1.—VERY LOW POWER. SHOWING GREAT DESTRUCTION OF LIVER LOBULES WITH DUCTS AND SINUSOIDS REMAINING. MARKED INFILTRATION OF AFFECTED AREAS WITH INFLAMMATORY CELLS.

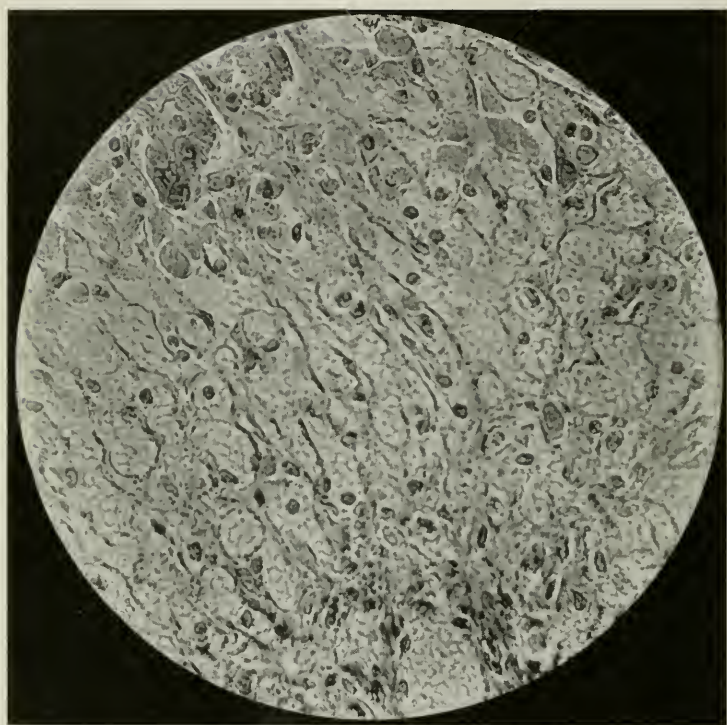


FIG. 2.—HIGH POWER. SINUSOIDS FILLED WITH RED CELLS AND PHAGOCYTES. BILE DUCTS AND PARTIALLY AUTOLYZED LIVER CELLS ON LEFT AND SMALL VEIN ON RIGHT.

that the fat granules were more numerous on the sides of the liver cells which rested against the sinusoids than upon the sides nearest the bile capillaries. The bile pigment was distributed evenly through the cells and was again found in the form of small casts within the bile capillaries between the cells. The peripheries of the lobules were often broken down and the periportal tissues intensely infiltrated with lymphocytes and plasma cells. The interlobular ducts often appeared isolated but did not show proliferation. The gall bladder mucosa showed extreme polypoid hyperplasia with no inflammatory infiltration of the deeper coats.

ANATOMICAL DIAGNOSIS.

Acute Yellow Atrophy of the Liver, General Icterus, Multiple Haemorrhages of Lungs, Bronchitis, Acute Tubular Degeneration of Kidneys, Fatty Infiltration of Myocardium and of the Kidney, and Hyperplasia of Gall Bladder Mucosa.

In the following synopsis of the chief pathologic lesions reported from autopsy findings in the TNT poisoning I have confined myself to tabulating those lesions which seemed to be due either to the direct or to the indirect effect of the poison and have ignored associated lesions definitely due to other causes. Owing to the fact that some observers have reported their findings in groups of autopsies rather than as individual cases the numbers are given only when ascertainable and as others have given only the chief findings in their cases the relative occurrence of the various lesions is only approximate. The anatomical changes are taken up by organs and discussed under the group headings of I. Toxic Jaundice; II. Aplastic Anaemia; and III. Other Lesions.

I. TOXIC JAUNDICE GROUP. The occurrence of lesions in the toxic jaundice group has been compiled from twenty-nine cases in reports by *Thurshfeld* (28) one case; *Livingston-Learmonth* (13) one case; *Martlandt* (14) one case; *Stewart* (3) eight cases; *Spillsbury* (8) seven cases; *O'Donovan* (1) two cases; *Oertel* (9) one case; *Turnbull* (5) three of his own and four submitted cases; and the case herein reported.

Liver Lesions. A greater or less degree of acute yellow atrophy was the characteristic finding of all of the Group I autopsies. The livers were all decreased in size and varied in weight from 12 to 45 ounces. The left lobe was in a more or less complete state of red atrophy in every case, and sections from these portions showed a constant finding of complete de-

struction of liver cells with only the bile ducts, blood spaces and stroma remaining. These structures were infiltrated with inflammatory cells and large pigment bearing phagocytes. There is a great variety in the descriptions of the right lobes but the essential characteristics are varying amounts of remaining liver tissue interspersed with foci of red atrophy. The less violently attacked liver lobules appear yellow and swollen but still maintain in a degree their characteristic arrangement. Some lobules remain in a fairly well preserved state and present little more than simple swelling. Microscopically the liver cells contain more or less fat, much bile pigment and no hemosiderin. The lobules show both peripheral and central invasion but the cells about the central vein show the greatest destruction. The periportal bile ducts lose their connection to bile capillaries and in many instances are described as undergoing regeneration. A certain amount of cirrhosis is described by many observers. *Gall Bladder*—Turnbull described acute inflammatory infiltration of the gall bladder wall in one case. The polypoid hyperplasia of the gall bladder mucosa was very marked in our case.

Brain and Meninges. Turnbull (5) reported injection of the leptomeninges and icteric staining of the choroid plexuses in the gross, and vascular engorgement of the cerebral capillaries with fatty change of their endothelial lining cells microscopically.

Circulatory System. Petechial hemorrhages of the pericardium have been reported in nine of the autopsies and of the endocardium in three instances. Microscopic fatty degeneration of the myocardium, demonstrated by Sudan III staining, has been described nine times. Turnbull described thrombi in the inferior vena cava in two cases.

Bone Marrow. Hyperplastic bone marrow of the red type has been described six times by Stewart in toxic jaundice cases, with one other instance where the marrow next to the bone was of the red variety and that in the center of the shaft of yellow color. Turnbull found the marrow red in two instances.

Lungs. In almost every case where the pleura has been mentioned petechial hemorrhages have been described. Hemorrhagic infarcts involving larger or smaller portions of the lung have been described four times and hemorrhages several other times. In one instance Stewart found lobar pneumonia, while bronchopneumonia was found by Turnbull and myself. Bronchiolitis was described in two instances. The icteric discoloration of the lungs was a constant finding.

Gastro-Intestinal Tract. Hemorrhages of the stomach have been described in five autopsy reports and were usually petechial in type. Submucous suggillations, free blood and tarry material have also been found. Spillsbury described acute gastritis in all seven of his cases. Gaseous distention of the entire bowel is a constant finding. Peritoneal and mesenteric petechiae were often found and ascites has occurred in a few instances.

Spleen. Jaundice and congestion and the general picture of a mildly septic spleen are the only lesions which I have found described.

Adrenals. The adrenal glands have been described by Turnbull in two cases and were negative in the gross, but showed small foci of necrosis microscopically in one instance.

Kidneys. The kidneys are described in the records of thirteen cases. They were always enlarged, flabby, bile stained and had smooth surfaces and swollen cortices. Microscopically acute toxic nephritis was diagnosed in one instance and pronounced fatty infiltration was described in every other instance where a microscopic study was reported. Oedema of the cortex and hemorrhage of the pelvis was found once.

Urinary Findings. The urine presents two characteristic features in TNT poisoning. One is the fairly constant presence of a body demonstrable by Webster's test and considered to be a product of TNT., since it gives the same test as the pure chemical. The other is the presence of bile. Webster's test (22) is performed as follows: To 12½ cc. of urine is added an equal quantity of dilute sulphuric acid made by adding 20 cc. of the concentrated acid to 80 cc. of water. Place the mixture in a separating funnel and add 10 cc. of ether. Shake and draw off the water and acid and wash the ether a second time with water. Finally mix the 5 cc. of the ether extract with 10 cc. of 4 per cent solution of caustic potash in absolute alcohol. If the TNT. product is present a pink color appears which changes rapidly to a purple and finally to a brown. Approximate quantitative tests may be made by having an arbitrary scale of five tubes running from a trace to an intense amount and making colorimetric comparisons. The intensity varies considerably with night and morning samples, being much stronger after recent TNT. exposure. The test is of great value in diagnosing doubtful cases and in estimating the rate of clearance from the system. There is great danger of accidental contamination in places where TNT. is handled because the crude material gives

the same reaction. Any positive reaction in the urine where acid has not been used means accidental contamination and cannot be accepted.

Feldman (6) has raised the question as to whether or not the substance found in the urine by Webster's test is really the same TNT. product to which the toxic symptoms are due. He bases his doubts on three main points: (a) The fact that the substance is not present in all Toxic Jaundice cases; (b) That Toxic Jaundice has appeared after employees have quit working with TNT. and after the substance giving Webster's test has entirely disappeared from their urine; (c) That extracts made from tissues stained with TNT. and other tissues degenerated from its poisonous action have never been made to respond to the test. Feldman thinks that the dangerous toxic TNT. product has not yet been demonstrated.

Bile is the other substance which is a constant finding in Toxic Jaundice. The urine in the hepatic cases sometimes becomes greenish-brown or nearly black a week or more before the actual atrophic condition of the liver becomes apparent and even before the jaundice of the skin has developed.

II. APLASTIC ANAEMIA. Six autopsies on aplastic anaemias to TNT. were found recorded: One by Martlandt (14), one by Panton (20), one by O'Donovan (1) and three by Turnbull (5). All of these are of the same type. One of them was accompanied with purpuric hemorrhages of all of the serous surfaces. One showed cortical hemorrhages of the brain and two other petechial hemorrhages of the meninges. Fatty degeneration of the endothelium of the capillaries was found by Turnbull. One instance showed marked fatty changes of the heart muscle and another tabby cat streaking beneath the endocardium. Three had subpericardial petechiae. The bone marrow of the femur was described as grey in one case, as fatty with pink spots in two cases, as pale pink in two cases and was not examined in the sixth instance. As for the microscopic changes in the marrow Turnbull found a relative excess of erythroblastic activity in the marrow of all bones examined and a great decrease in the number of megakaryocytes. He found numerous plasma cells and large phagocytes containing pyknotic nuclei, erythroblasts, erythrocytes and coarse granules of iron pigment. The lungs were edematous twice and hemorrhagic once. Hemorrhages were described in the mouth and about the teeth in two instances and twice in the stomach. The liver was

moderately degenerated twice, once decreased in size and resembled somewhat the liver of acute yellow atrophy. One liver was of the nutmeg type, and intense hemosiderin pigmentation of the peripheries of the lobules was reported three times. Turnbull considered the pigmentation to be due to haemolysis and not to phagocytosis. Fatty degeneration of the convoluted tubules of the kidney was constant as was also anaemia, oedema and parenchymatous degeneration of the tubules.

III. OTHER LESIONS. Four autopsies are recorded where neither the typical liver lesions of toxic jaundice nor the presence of a severe anaemia existed. Turnbull (5) has reported a case of "Slight Jaundice" in a man fifty-two years old who was an amatol worker, and who died with slight jaundice, with many petechiae of the skin and with duodenal perforation but not peritonitis. The liver contained two separate sunken areas in which the hepatic tissue was atrophic and showed areas of complete destruction of liver cells similar to that seen in acute yellow atrophy. Many of the hepatic veins were closed by endophlebitis. The remainder of the liver was traversed by irregular trabeculae similar to those found in common portal cirrhosis. Common portal cirrhosis with TNT, as a complication was ruled out on the absence of newly formed elastic tissue fibres. No anaemia was present. Turnbull believed that all the TNT, destructive action had ceased in the liver and that it was undergoing extensive regeneration. Wagner (29) reported a fatal case of Bronchiolitis Obliterans following an acute gassing which occurred during a TNT. explosion. He summed his findings as follows: "A man aged thirty-nine years, with an antecedent history of lues, was accidentally subjected to the inhalation of irritating gases. At the time of the accident he suffered nothing more than a severe fit of coughing. Three days later dyspnoea suddenly developed, increasing continuously until the time of his death, three weeks later. During his illness his most marked clinical manifestations were dyspnoea, cyanosis and some edema of the feet and hands. Clinically, no pulmonary consolidation could be discovered, but the chest examination indicated mainly a bronchial involvement. At autopsy numerous small fibrous foci were observed in the lung tissue, suggesting miliary tuberculosis, but not showing any evidence of necrosis which marks these lesions. The microscopic analysis showed the presence of inflammatory reactions in and about the bronchioles, accompanied by a process of organization. In this way it differed from a pro-

cess of broncho-pneumonia, to which, however, it had the closest resemblance." Spillsbury (8) mentioned autopsies on two cases which showed neither severe anaemia nor jaundice. One presented nothing abnormal; the other showed cyanosis and a moderate anaemia with a high color index.

DISCUSSION OF PATHOGENESIS OF TOXIC JAUNDICE LESIONS.

TNT. is absorbed by the tissues of the body whether it is by the skin, through the intestinal tract, by way of the air passages, or by all of them together. This is shown by the presence of a substance in the urine, demonstrable by "Webster's test." This substance is accepted as a product of TNT. but perhaps not the most poisonous product of it. After the absorption of the poison there is a latent period when no apparent progress is made by the poison on the tissues. This latent period may last for days or weeks as is shown by many instances where victims have sought other employment or ceased to be exposed to TNT. and later developed acute yellow atrophy. I may become permanent as the great majority of workers never develop poisoning. After the elapse of an uncertain period the progress of the poison becomes manifest. The patient becomes uneasy and the urine becomes bile stained which is an infallible sign of liver disturbance either toxic or obstructive. Next we have the appearance of icterus showing great absorption of the bile pigment by the blood, without local symptoms of obstruction. Then we have the occurrence of vomiting and hemorrhages and the appearance of oedemas probably secondary to liver insufficiency and finally liver destruction in sufficient amounts to give physical signs of its decrease in size. Leaving out of account just what balance occurs between the liver cells and the toxic TNT. product it seems that the theory developed by Wells (24) with reference to the old idiopathic forms of Acute Yellow Atrophy is applicable here and that the cells are acted upon by a poison which destroys their synthetic action without destroying their intracellular proteolytic enzymes causing them to undergo autolysis from their own ferments. As an additional point in favor of this view, witness the preservation of the interlobular bile ducts, which so far as we know are exposed in the same way to the poison but which do not contain known proteolytic enzymes. Also note the slight action of the poison on the stroma and on the walls of the sinusoids. Oertel has suggested that TNT. is a poison affecting the endothelium lining the blood vessels and

lymphatics leading to the development of hemorrhages and massive oedema, and thus bringing about secondary cytolytic necrosis. It seems to me much more likely that the autolysis of a great portion of the liver cells, robbing the body of its carbohydrate store house, cutting off most of the nitrogen excretion, liberating organic aromatic acids and preventing the escape of the bile into its proper channels and bringing about acidosis, uraemia and icterus in this way is a sufficient explanation for the hemorrhages and edemas, as well as vomiting, etc., even if TNT. has no toxic local action on any tissues outside of the liver. Practically all of the other findings are seen in uraemia and acidosis which can be brought about experimentally by an Eck fistula connecting the portal vein to the inferior vena cava above the liver thus shutting it out of the circulation. I do not wish to lay stress on having found a positive Webster's test on bile aspirated from a gall bladder in an extremely early case of experimental TNT. poisoning, but microscopically there was little liver destruction in this instance and it suggests to me that TNT. may be excreted through the liver cells until they are sufficiently damaged to begin autolysis, that in a later stage the destruction is so great that it can no longer reach the bile passages, and so it is freed in the liver substance to be again absorbed in the blood. As to the assertion that the centers of the lobules are first attacked I am uncertain. That they show the most extensive destruction in my case is plain, but the lesion is likely comparable to the central necrosis of chronic passive congestion. It is not that the pressure or the toxic substance is greatest near the central vein, but that the cells seem less resistant to all sorts of deleterious influences.

The degenerations of the heart muscle cells are probably the result of the general toxæmic condition although some direct TNT. action cannot be ruled out. The fatty change in the tubular epithelium of the kidneys is probably due both to the general toxic condition and to the elimination of TNT. products as for example that shown by Webster's test. However, the lesions are not due to that substance alone because the test may be positive for a long time without kidney symptoms and the kidney lesions at autopsy appear very acute. The lungs require a somewhat more extended account because they are attacked in two ways. (a) Through the general toxic action of substances in the blood from which probably come the local hemorrhages and the slowly developing edemas. In my case I first thought the hemorrhagic areas were infarcts but as repeated sections showed no evidences of thrombi, emboli or of other obstruction

to the vessels I concluded that they were small hemorrhages of a massive type and of some days' duration as shown by the great number of golden pigment bearing endothelial cells found in their borders. (b) The direct action of the fumes are responsible for the desquamation of the bronchi and the bronchiolitis. Dr. Matthewson has stated that secondary infections after gassing and severe edemas are common and it is easy to believe that hemorrhages may also result from the direct irritation of the gas. Dr. Wagner's case of Bronchiolitis Obliterans (29) belongs in this group. I am indebted to Dr. Klotz for having had the opportunity of studying some of Dr. Wagner's sections. In my series of organizing pneumonias I have had two instances in which the organizing process has extended into, and closed the bronchioles. The histological lesions in my cases are in no way at variance with those described by Wagner, except that perhaps a greater portion of the alveolar tissues are involved and that the history and clinical findings in my cases showed them to have followed lobar pneumonia. Therefore, the bronchi in my cases were probably secondarily involved and not primarily as described in Wagner's case. In the light of our present knowledge of TNT poisoning and perhaps more especially because of Matthewson's observations regarding the predisposing effects of gassing to bronchial infection, I am inclined toward the belief that the findings in Wagner's case were due to an infective bronchiolitis and peribronchiolitis which followed the gassing rather than to the direct chemical effect of the fumes. The history of late onset of symptoms, their progressive nature and Wagner's observation that the organizing process was not all of the same age seems to me to be additional evidences of infection. Had the organizing process begun in hemorrhagic foci or in a generalized exudate of relatively sudden origin, the symptoms would likely have been severe from the first. If the irritation had been gradual and prolonged a general decrease in the size of the lumen due to peripheral encroachment would have been the more likely sequence.

PATHIOGENESIS OF ANAEMIAS.

Turnbull has offered an explanation for the cause of the anaemias. He believes that they are due to the effect of TNT, or some chemical derived from it on the blood-forming cells in the marrow and also to increased blood destruction in the circulation which he considers is shown by the finding of large quantities of haemosiderin in the liver.

TNT. POISONING A TRUE ACUTE YELLOW ATROPHY.

Several workers have attempted to differentiate TNT. toxic hepatitis from the lesion long since known as acute yellow atrophy. The points made were those of greater fat content and less bile precipitation within the liver cells and in the phagocytes in TNT. poisoning than in yellow atrophy. In my sections no such differentiation could have been made because the sections from the best preserved areas presented the differential points in favor of TNT. and the more advanced areas in which only islands of liver cells remained satisfied all of the requirements of acute yellow atrophy. A review of the descriptions cited above will show that while individual instances may vary slightly the majority of findings go to prove that TNT. can, and does produce the typical classical lesions of acute yellow atrophy.

The study of T. N. T. toxic jaundice throws considerable light on the whole question of liver lesions and by giving us tangible knowledge of the relations between the acute changes and the clinical data promises to clear up in a measure at least one class of cirrhosis of the liver. Mallory (23) classified one group of cirrhoses as being due to the end products of toxic destructive lesions similar to acute yellow atrophy and future autopsies on cases who have recovered from severe T. N. T. toxic jaundice attacks should definitely determine this point.

PREVENTION.

Trinitrotoluene poisoning is a disease which lends itself more readily to prevention than to cure. The British Ministry of Munitions (15, 25) has issued a long list of rules controlling the employment and hygiene of munition workers. Some of the things insisted upon are: The employment of no persons under eighteen without special permission, rotation of work at two weeks intervals, large and well ventilated work rooms, good and serviceable lavatories, the use of masks, gauntlets and regularly laundered overalls, the furnishing to employees free, of milk or cocoa daily, and regular weekly medical inspection by a physician. By the close observance of these rules poisonings could be practically eliminated.

SUMMARY AND CONCLUSIONS.

Trinitrotoluene may be absorbed by the body by way of the skin and alimentary tract and probably also by the lungs. It forms toxic products in the body, at least one of which is demon-

strable in the urine. Under certain conditions, TNT, or some chemical compound of it attacks the liver and produces lesions which are anatomically identical with those known as acute yellow or acute red atrophy. The condition is accompanied by a general icterus of the skin and about one-fourth of the cases end fatally. In other instances the blood forming centers of the bone marrow are destroyed and a form of aplastic anaemia is the result.

Thanks are due to Drs. Matthewson, McKelvy and Schildecker for their permission to report this case.

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A FATAL CASE OF TOXIC JAUNDICE CAUSED BY DINITROPHENOL.

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Poisoning by *dinitrophenol* is not mentioned by either Thompson or Oliver. Dr. Alice Hamilton, likewise, does not mention it in the Government Bulletin of occupational poisoning in munition workers. In a personal communication, however, she writes that she knows of no cases of dinitrophenol poisoning in this country, although she has suspected that some of the cases of picric acid poisoning reported were in reality dinitrophenol cases. Kober says that "Dinitrophenol may cause acute symptoms of industrial poisoning similar to those observed from nitrobenzol."

The physiologic and toxic action of the nitrophenols (para-, di-, meta- and ortho-) has been studied by Baumann and Herter, Hammerbacher, Gibbs and Hare, Röhl, Gibbs and Rechert, and Leymann. The fatal dose of dinitrophenol for a 1 Kg. dog was found to be 0.05.; when injected into the jugular vein the heart's action was markedly inhibited, the activity of the motor nervous system lowered and death occurred through respiratory or cardiac paralysis. Degenerative changes were found in liver and kidney, poikilocytosis without brown coloration of the red blood cells in the dog, and methemoglobin in the cat. These early pathologic studies are very incomplete and of little value. The experimental work was carried out chiefly from the physiologic side and little study made of gross or microscopic pathology.

There apparently exists in the literature only one observation of the pathological changes occurring in a fatal human case of dinitrophenol poisoning. (*Barral et Martin*: Intoxication par le dinitrophenol, Lyon Médical, Vol. 125, 1916, p. 276); at least,

I have been unable to find any other. In the case reported the patient had been working for six months in a powder factory, engaged in the drying of dinitrophenol after its washing with water. When the turbines were active he was exposed to an atmosphere containing a fine spray mixed with particles of dinitrophenol. Until the day of his death he had not presented himself to the medical service. He was taken suddenly ill at mid-day, after leaving his work at the usual hour in the morning. The physician who examined him at the time found him suffering from intense headache, vomiting, bronchial rales, cardiac arrhythmia, pulse 110, temperature 40.8°. After a slight amelioration at thirteen hours, he died at fourteen and a half hours.

Autopsy showed the skin of the hands, feet, abdomen and forehead colored yellow; the hairs also were yellow. In the trachea and large bronchi there was a blood-tinged froth. The lungs showed a marked oedema; the other organs appeared normal. In the absence of any condition explaining the cause of the pulmonary oedema, the various organs and their contents were subjected to a toxicological examination. The urine contained albumin, aminonitrophenol and traces of dinitrophenol. No nitro-derivatives were found in the stomach. The bloody fluid and sputum obtained from the cut surface of the lungs showed a marked content in dinitrophenol. From the lungs and the blood of the heart there was obtained a notable quantity of dinitrophenol. The liver contained aminonitrophenol without dinitrophenol. The reduction of dinitrophenol to aminonitrophenol appeared to be carried out chiefly in the liver. In the kidney a trace only of aminonitrophenol was found. The stomach contained no trace of nitro-derivatives.

Death was regarded as due to an *acute pulmonary oedema* due to the absorption by the lung of dinitrophenol. As the man was an alcoholic the specific action of the poison upon the lungs was thought to be favored by his alcoholism, the presence of alcohol favoring the dissolution of the dinitrophenol, and the alcoholic degeneration of the body retarding or preventing elimination of the poison.

The authors further state that as the result of experiments, as yet unpublished, upon the toxicity of dinitrophenol, the quantity of dinitrophenol found in the body of this case is not sufficient to explain his death on the grounds of a general intoxication.

They conclude that alcoholics and men presenting hepatic, pulmonary or renal lesions should not be employed in the handling of this product. On the other hand to prevent accidents that

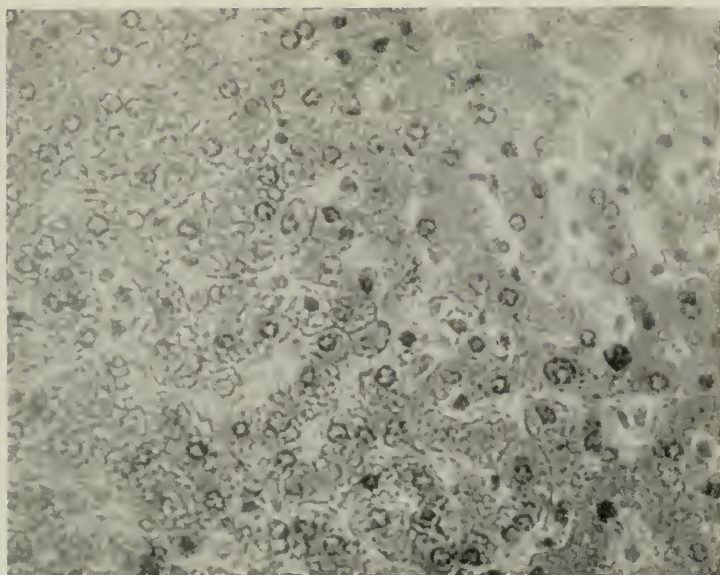


FIG. 1.—BORDER OF DEGENERATED AREA OF LIVER LOBULE, SHOWING THE FATTY DEGENERATIVE INFILTRATION AND SIMPLE NECROSIS OF THE LIVER CELLS.

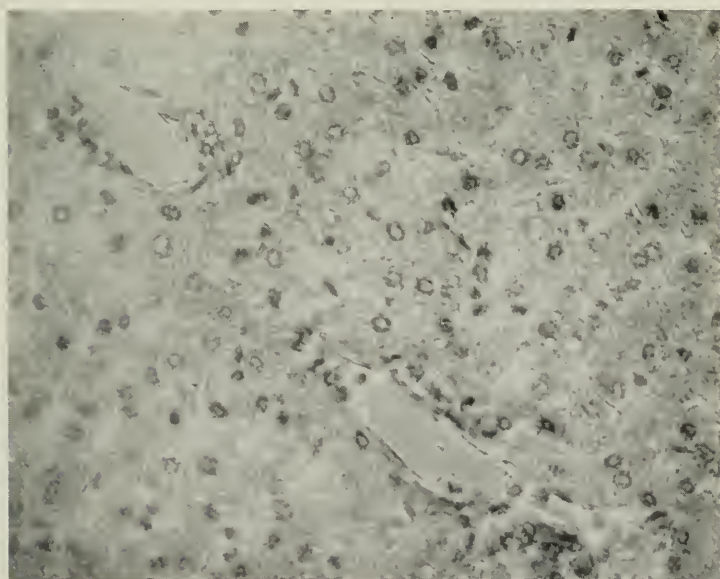


FIG. 2.—AGGLUTINATION RED BLOOD CELL HYALINE THROMBI IN CENTRAL AND SUB-LOBULAR VEINS IN THE AREA OF FATTY DEGENERATION AND NECROSIS OF THE LIVER LOBULE.

possibly might be fatal, the turbines should be covered while they are in use, and the workers should wear a mask during their manipulations.

In October, 1917, there was received at my laboratory a specimen of urine and liver from a man dying in a chemical plant where dinitrophenol was being manufactured. The man was said to have died "with all the symptoms of some kind of poisoning." No data concerning his symptoms in detail or the post-mortem findings were furnished us beyond the fact that he was jaundiced.

URINE EXAMINATION.

(*Dr. Weller.*)

Sample consists of 2 ounces of dark yellowish-red urine, slightly smoky, but with a definite greenish coloration.

Slightly turbid. Reaction faintly acid.

Albumin,—trace.

Bile pigment,—abundant. Foam bright yellow on shaking, Rosenbach's test for bile pigment, positive.

Microscopical examination of sediment obtained by centrifugation shows. no crystalline elements. Very rich in epithelial cells, chiefly renal.

Tests for phenol derivatives, (both dinitro- and trinitro-) strongly positive. A portion of the urine was treated with bromine water. A precipitate was gradually thrown down. This was flocculent at first but later settled out as a heavy yellowish white solid (tribromophenol). Another portion was rendered strongly alkaline with NaOH when the color changed from light yellow to a deep orange red. These tests were duplicated upon normal urine to which a small amount of 5% phenol was added and then changed to nitrophenol by boiling with nitric acid.

PATHOLOGY OF LIVER.

Liver grass-green, icteric, capsule wrinkled, lobules smaller than normal to the naked eye.

Microscopically, the capsule is wrinkled, thrown into numerous folds, indicating very recent reduction in size. Lobules are smaller than normal. All blood vessels greatly congested, particularly central and sub-lobular veins. The central portions of the lobules are greenish, brownish or yellowish-stained from the acute icterus present, bilirubin in the liver-cells and bile capillaries. The liver cells in the central zone are disassociated, and show cloudy swelling, early necrosis, and fat droplets. Minute

fat droplets (degenerative fatty infiltration) are present throughout the entire lobule, but are much more prominent in the intermediate and peripheral zones. (See Fig. 1.) These changes vary greatly in degree, being very much more marked in certain areas than in others. The blood vessels show an increased number of leukocytes and many of the periportal islands show a definite leukocyte infiltration. Hyaline and agglutination red cell thrombi are found in many of the intralobular capillaries. (See Fig. 2.) Brownish fragmented red cells occur also in the capillaries.

The microscopical appearances are those of a very acute degenerative hepatitis, the changes not differing from those seen in the liver as the result of many hepatotoxic poisons: chloroform, arsenic, TNT, phosphorus, etc., and in acute yellow atrophy and eclampsia. The only distinguishing feature, if there is one, is in the large number of hyaline thrombi present in this case. There appears to have been a very marked destruction of the blood cells. The urine shows a similar degenerative toxic action upon the kidneys, as revealed by the marked desquamation of tubular epithelium.

This case, while, unfortunately, incomplete in the absence of a thorough autopsy, shows evidence of a poison causing marked degeneration of liver and renal epithelium, acute degenerative hepatitis, with icterus, agglutination of red blood-cells, formation of hyaline thrombi, with the demonstration in the urine of nitrophenols.

Dinitrophenol must be added to the list of dangerous occupational hepatotoxic poisons, capable of producing acute yellow atrophy and toxic jaundice. At this time it is, therefore, increasingly important that suitable protection be provided for workers with this product in munitions manufacture.

THE PATHOLOGY OF GASSING.*

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A large and almost entirely new field of pathology has been opened up by the modern use of poisonous gases in warfare. Until the deliberate and studied adoption of this means of attack by the Germans in April, 1915, most of the types of gassing, which have now become all too common, were known only through the

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rare occurrence of laboratory and industrial accidents. Some of them, induced by hitherto little known organic compounds, are without precedent in pre-war medical literature. But now research in the pathology of these conditions has come to be not alone a matter of scientific interest, but an absolute necessity to the successful conduct of the war.

The literature upon the pathology of gassing is, for the greater part, characteristic of the mass of material which has accrued to each of the important medical aspects of the war. As will be seen in this short review and the accompanying bibliography, the published work directly and indirectly concerned with this subject has already become voluminous, comprising considerably more than one hundred titles. Unfortunately, however, relatively few of these articles contribute materially to an exact understanding of the lesions produced by the various agents employed in military gassing. The reasons for this are obvious and sufficient. In the emotional stress and strain of the first gas attacks in Flanders, all attention was rightly turned toward means of alleviation and protection, and these considerations, together with the highly colored but none too scientific descriptions of the refined tortures there witnessed, fill the articles of that period. The rapid progress made in elaborating the method of the gas attacks with the frequent changes in the agent used, seemed to leave little time or opportunity for approaching the problem either by the experimental method or through the careful study of the gross and microscopical changes found at autopsy. Uncertainty as to the identity of the gas causing the particular casualties in question has rendered many of the case reports of little value and the fact that a mixture of irritative and asphyxiative gases rather than a single substance has usually been employed has introduced much confusion in attempting to assign to components of the mixture precise causative effects. Still another reason for the somewhat disappointing character of this literature, considered as a whole, has been the military necessity of withholding from publication, for a time, at least, data concerning the character of the gases used on certain occasions and the morbidity and mortality produced by them. Notwithstanding these handicaps a number of excellent papers have already appeared and the general adoption of the experimental method in attacking this problem promises much for the future.

The use of cloud or drift gas and of charged explosive shells, bombs, grenades, etc., are the two methods by means of which gassing is usually accomplished. The first of these, al-

though singularly successful when first employed, is in reality strictly limited in its application since only those gases which are considerably heavier than air and which can be provided in enormous quantities can be thus employed. Its use is likewise dependent upon favoring atmospheric and topographical conditions. None of these factors is concerned in the dissemination of poisonous gases by means of charged shells and grenades, so that this method is available at all times for a very large number of gases and volatile liquids. In addition, gassing, as it occurs in warfare may be brought about by a number of other methods. In military mines it may occur from exposure to either nitrous fumes or carbon monoxide generated in previous explosions in the same area. Sundell (80) states that in the area with which he was familiar more casualties occurred during the few days subsequent to the explosion of a hostile mine than at the time of the explosion itself. The carbon monoxide permeated the friable chalky soil or was confined in fissures produced by the explosion only to be released by fresh workings or puffed out into the mine by the settling of the soil. In naval warfare (Carpenter (56)), likewise, gassing is an important factor and here the chief hazards are from smoke and explosion gases. These may be derived from fires starting below deck, from funnel smoke entering pierced ventilators and thus reaching all parts of the ship, from the bursting charges of exploding enemy shells, from the powder gases of the ship's own guns, or even from overheated lacquer and paint on turret guns (in the U. S. navy the breaches of the guns are unpainted). The transportation of troops by automobile has introduced still another gassing hazard and accidents similar to the garage deaths of civil life are met with. Such a case is described by Teynac (81). Eight officers who were being transported in a closed automobile from one sector to another were found unconscious on the floor of the vehicle at the end of the three and one half hour journey. It was subsequently shown that exhaust gases could enter the enclosed compartment through the floor. In this instance all of those overcome eventually recovered. In both France and Germany soldiers have been poisoned by arsine, produced as an impurity in the generation of hydrogen for filling balloons (Cevidalli (57)).

Lists of the gases used in the present war have been compiled by Hill (20), Cevidalli (57), Gallo (66), Filippini (64), and others. Some of these authors have included with gases known to have been used, others said to have been used but not yet verified. The list given by Vaughan (106) is the most recent and complete.

for it includes many of the organic compounds which have played so large a part in the past year. Those gases and volatile liquids known to have been used include chlorine, phosgene, hydrocyanic acid, phosphine, arsine, hydrosulphuric acid, dichlorethyl-sulphid (mustard gas), chloropicrine, acroleine, methylchloro-sulphate, bromide of benzyl, chloracetone, bromacetone, iodacetone, bromacetic ether and iodacetic ether. Others, the use of which has been less authentically stated or implied are nitrogen peroxide, carbon monoxide, sulphur dioxide, bromine, cyanogen, arsenic trichloride and phosphorus trichloride. Regardless of their intentional use as gassing agents, carbon monoxide and nitrous fumes have to be considered because of their production as explosion gases and as products of the burning of explosives without detonation. In the open there can be but little danger from these two, but in military mines and underground shelters they play an important part.

The pathology of many of the gases above mentioned is at present understood only in the most general way and attempts to group them according to similarity of action are far from satisfactory. Arsine, phosphine, hydrocyanic and hydrosulphuric acids are known to cause death directly, that is, by virtue of their intrinsic toxicity. On the other hand, chlorine, phosgene and many others are more commonly described as causing an asphyxiative death by reason of pulmonary changes. As will be seen, however, there are many reasons for thinking that this is but a matter of degree and that death may be as direct and almost as immediate after chlorine gassing as after hydrocyanic acid. Similarly, those gases which are characterized by their lacrymatory effect and are thus grouped together are in some instances extreme respiratory tract irritants as well, and in sufficient concentration may produce an asphyxiative death through pulmonary oedema. The so-called mustard gas has both of these properties, but is still more notorious by reason of the skin lesions which it produces by direct contact. It will thus be seen that for the present the pathology of gassing can be considered only from the standpoint of the lesions produced by individual gases.

CHLORINE. Chlorine has a density of 2.450, is liquid at ordinary temperatures under relatively low pressure and is highly irrespirable. It is therefore well suited to use as a cloud or drift gas. Klotz (90) found that a concentration as low as 1 part in 10,000 would produce acute poisoning in small animals. Filipini (64) gives .05% as a fatal concentration while one of .4% to .6% produces speedy death. In experimental animals death

may be produced within one to two minutes with higher percentages.

The symptomatology and pathology of chlorine gassing depend entirely upon the concentration of the gas and the duration of exposure to it. All show from the first the most intense irritation of the respiratory mucous membranes with incessant coughing. Those most severely affected die in the trenches within a few minutes, with or without haemoptysis, and when found have a faint greenish yellow appearance like that of asphyxia pallida (Bradford & Elliott (6)). The literature affords no record of post mortem findings in these immediately fatal cases. In dogs similarly poisoned, the peripheral vessels do not bleed at autopsy and the lungs are found to be shrunken, dry, bloodless and friable. Men who survive the attack for a few hours develop the most intense acute pulmonary oedema with extreme cyanosis, dyspnoea and very abundant frothy expectoration, often blood tinged. Most of the deaths occur in this stage. Autopsies of cases dying during this asphyxial stage show (Black, Glenny & McNee (5), Henry (18), and others) a well marked inflammation of the pharynx and larynx without membrane formation, intense congestion and oedema of the trachea and larger bronchi, and a most extraordinary oedema of the lungs such that the patient has literally drowned in his own body fluids. Sub-pleural haemorrhages are practically always present, evidence of the essentially asphyxiative character of the death. Sub-epicardial and sub-endocardial haemorrhages may also be present. Interventricular emphysema is common and mediastinal emphysema by no means rare. In 7% of the cases (Sisto (79)), there is a sub-cutaneous emphysema appearing at the base of the neck and spreading over the anterior surface of the thorax, reaching eventually to the abdomen and scrotum. The heart is dilated, particularly on the right side. All abdominal organs show marked passive congestion. The stomach in all cases shows a marked catarrh and in most cases sub-mucous haemorrhages.

As the intense oedema disappears, the frothy sputum gradually becomes more purulent and a severe muco-purulent bronchitis develops. In this stage the damaged lung tissue is especially open to bacterial invasion and pulmonary gangrene or pneumonia may terminate the picture. Those who have been severely gassed with chlorine, recover but slowly and for months are dyspnoeic and cyanotic on slight exertion. Just what the reparative processes may be in these cases is not yet known but it seems probable that there is marked increase in the fibrous connective tissue

of the lung and that the more severe cases undergo to some extent an obliterative bronchiolitis.

As the most striking feature, both of the symptomatology and of the gross pathology of chlorine gassing, the pulmonary oedema has aroused much interest. Its appearance is so rapid that it scarcely seems possible that it could be purely inflammatory in character. According to Hill (20), the exudation follows directly upon, and as a result of, the injury to the surface epithelium and underlying capillaries and he cites experimental evidence in support of his belief. Schäfer (42), on the contrary, by a series of elaborate studies on cats, rabbits and dogs came to the conclusion that chlorine produces its fatal results by causing obstruction of the pulmonary vessels, amounting in some cases to complete stasis. He also called attention to the vicious circle between oedema and vascular obstruction.

This conclusion of Schäfer's has been supported and explained by observations upon the blood and circulatory changes in chlorine gassing, which, taken as whole, represent the most important advance that has been made in the pathology of gassing. It has been repeatedly noted that the blood of chlorine gassed patients coagulates with great rapidity. So marked is this change that therapeutic blood-letting is oftentimes a matter of much difficulty. The dark colored, thick, viscid blood flowing sluggishly from even large veins is frequently described. Pulmonary thromboses and infarction are also noted in the earlier autopsy reports but no great stress is laid upon their importance, yet thromboses elsewhere in the body are mentioned in case reports with significant frequency. For instance: Giroux (13), describes a case of hemiplegia consequent to chlorine gassing which he attributes to the thrombosing action of chlorine; Sisto (79), notes thrombosis of a brachial artery; Bradford and Elliott (6), record three cases with vascular obstruction in the lower extremities, with progressive loss of the arterial pulse, coldness and lividity of the limb and threatened gangrene; Kramer's (91) case showed pulmonary and coronary thrombosis together with a parietal thrombus of the left ventricle; Boldireff (83), warns that there must be no rubbing of the gassed patient in order to warm him as this is liable to induce embolism. Pozhariski (39), finds that among the severe changes, noted in cases dying in the first twelve hours after chlorine gassing, is the marked increase in the coagulability of the blood rendering it thick and unable to circulate freely. He finds white thrombi in many cases and concludes that the blood changes and thrombus formation so embarrass the work

of the heart that tissue asphyxia results. He further states that embolism and infarction are to be expected among the complications.

Hake (15) investigated the direct action of chlorine upon the blood *in vitro*, but the conditions of his work were not such as to throw light upon the factor of coagulability. He did find, however, that the characteristic dark bands of the oxyhemoglobin absorption spectrum, as obtained in dilute blood, are discharged by adding chlorine water drop by drop and that if chlorine gas is allowed to bubble through dilute blood, the iron of the hemoglobin, at least in part, passes into solution in the colorless filtrate and can be there demonstrated by the usual tests. He calls attention to this permanent destruction of the hemoglobin as a possible explanation of the immediately fatal cases of chlorine gassing, since this change if it takes place in the human body would be more serious even than the more or less temporary fixations of carbon monoxide and cyanogen with hemoglobin.

The recently published work of Klotz (90) is an important contribution to the study of the blood changes in chlorine gassing. He finds that in severely and fatally gassed animals there is microscopical evidence of coagulation within the dilated capillaries. While this may be the result of the abstraction of fluid, as may also be the increased viscosity of the blood, it seems more probable that the local and direct effect of the chlorine hastens coagulation for he shows that human blood in an atmosphere of 1-1000 chlorine coagulates in about 15 seconds and more rapidly in stronger concentrations. He does not, however, assign this as the sole reason for the acute deaths. "It would appear that the acute deaths of the experimental animals were the direct result of obstruction of the pulmonary circulation and that the presence of the pulmonary oedema was a factor in this regard." If the individual lives somewhat longer, the fatal result is more particularly associated with the oedema.

It will thus be seen that the most important action of chlorine is, perhaps, its power to lower the coagulation time of the blood. If further experimental work supports this view, it will completely alter all former conceptions of the pathology of chlorine gassing. As a working hypothesis, it explains the immediate deaths; the dry and almost bloodless condition of the lungs in animals gassed with rather high concentrations; the initiation of the vicious circle which includes pulmonary stasis, pulmonary oedema and cardiac dilatation; and the thrombosis, infarction, embolism and multiple haemorrhages which are part of the clinical picture.

The changes in the cellular elements of the blood are apparently not important. The erythrocyte count, as reported, is usually about normal although the concentration of the blood by the extreme pulmonary oedema must be remembered. Evidence of a slight hemolytic icterus has been given in a few case reports, but hemolysis does not play any great part. Heitz (16) quotes below that the hemoglobin reading of fifteen subjects examined on the eighth to eleventh day averaged 100%. The white cells in this same series of cases ranged from 7000-10,000. Miller (97) finds that a case which has been gassed sufficiently severely to produce symptoms lasting for some time shows a more or less marked relative lymphocytosis which takes some time to develop, three to four months, at least. This he attributes to chronic inflammatory changes in the lung.

The gastro-intestinal lesions in chlorine gassing are also important. Acute epigastric pain, with vomiting, oftentimes bloody, is very frequently one of the early manifestations. Altered blood may be vomited for several days following the gas attack and those who have been at all seriously affected usually show anorexia and intolerance of food. Leoper, Peytel and Sabadini (30) describe cases which had unmistakable signs of a severe erosive gastritis, eventually relieved by bicarbonate of soda and a milk diet. Reference has already been made to the post mortem changes in the stomach; congestion, petechial haemorrhages, patches of bloody suffusion and in some cases ulcerations. Bradford and Elliott (6) found the stomach full of blood in two out of sixteen autopsies. Similar but less marked changes have been described for the duodenum. Sergeant and Agnel (43) attribute the gastric changes to local caustic action from swallowing the gas. They are more probably asphyxiative, embolic or thrombotic.

In regard to changes in the central nervous system Neiding (100) states that of 274 cases of drift gas poisoning (probably chlorine but possibly chlorine combined with phosgene) more than 50% presented objective nervous manifestations. The headache and feeling of extreme fatigue are considered by Bradford and Elliott (6) as signs of toxic lesions of the central nervous system but they found no gross changes in the brain at autopsy. Miliary haemorrhages are described by several but they seem to be a much less constant finding in chlorine than in phosgene poisoning.

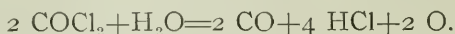
Chlorine gassing does not produce characteristic parenchymatous changes in either liver or kidneys. Surprisingly few

cases have shown albuminuria. After the first week the percentage is higher but this is doubtless to be attributed to the advent of pulmonary infections. Bradford and Elliott (6) found that in all men dying in the second week the kidneys showed the changes of a moderate acute parenchymatous nephritis, yet none of them had had oedema and only one uraemic symptoms; and the authors emphasize the usual absence of albumin and casts in their gassed cases.

Sergeant and Agnel (43) suggest that the feeling of general weakness, the great fatigue, the hypotension and fall of temperature call to mind the phenomena of suprarenal insufficiency. Voivenal and Martin (107) insist that gassed cases show a suprarenalitis with insufficiency. There is, however, no gross or microscopical evidence of structural changes in the adrenal in cases known to be due to uncomplicated chlorine poisoning.

PHOSGENE. COCl_2 , carbonyl-chlorid. Phosgene is a liquid which boils at 8.2° giving off a colorless gas which is exceedingly suffocating and irritative. The density of the gas is 3.49 as compared to air. It is used both as a shell gas and a drift gas, in the latter case usually mixed with nine parts of chlorine.

Phosgene poisoning closely resembles chlorine poisoning but is considered by all as being more serious. Vaughan (106) says that phosgene is twenty-four times as effective as chlorine and Filippini (64) gives 0.25% as a concentration which is rapidly fatal. The toxic action has been attributed to carbon monoxide produced by decomposition in the presence of water according to the formula,—



but this is probably not the true explanation.

The pre-war literature dealing with the lesions of phosgene poisoning has been reviewed by Filippini (64). He cites the cases of Müller and of Roos as reported by Bilancioni. One of Müller's cases came to autopsy showing a marked dilatation of all the chambers of the heart. The five cases of Roos showed in life, cough, cardiac dilatation, weak pulse, marked cyanosis, polycythemia, marked leucocytosis with lymphopenia, and albumin, indican, urobilin and casts in the urine. Autopsy of the two cases which died showed focal pneumonia, sub-pleural haemorrhages, acute bronchitis, multiple thromboses of the pulmonary arteries, fatty degeneration of liver and spleen, and minute thromboses of cerebral and intestinal vessels.

In experimental phosgene gassing of rabbits and cats Bilancioni (54) found the most severe contact lesions, the mucosa

of larynx, trachea and larger bronchi being in a state of necrobiosis and desquamating in large strips. There was marked pulmonary oedema and congestion with thromboses and haemorrhagic infarctions. In some cases the intrinsic laryngeal muscles showed fragmentation, which he thinks may have been due to, or favored by, the convulsive opening and closing of the larynx. The laryngeal lesions, particularly the haemorrhages into the sub-mucosa, and the extreme pulmonary oedema he considers the most important features.

Similar pulmonary lesions are found in the human cases, and the occurrence of thromboses is also repeatedly mentioned. The Italian writers emphasize the frequency of thrombosis of mesenteric vessels resulting in some cases in a diffuse necrotic enteritis and localized peritonitis. Punctiform haemorrhages in the brain are also a frequent finding. These are considered by Mott (98) as of embolic origin, possibly due to pigment granules of altered hemoglobin. In the brains of two cases of drift gas poisoning he found the white matter peppered with innumerable haemorrhages, each about the size of a pin head. These were microscopically like those of carbon monoxide poisoning except that the haemoglobin appeared to have been largely converted into chocolate colored granules, a change which he thinks may have been due to the action of hydrochloric acid, liberated from the phosgene, in converting the haemoglobin into acid haematin.

BROMINE. Density as compared to air, 5.52. Boiling point, 59°. Although organic bromine compounds are now being used extensively, there is little evidence in the literature to indicate that bromine itself has ever been employed. Animal experimentation has been carried on with it in this connection, however, to an extent second only to that in the case of chlorine. Symes (46), and Symes and Golla (47), using a high concentration of bromine vapor on pithed cats, found a marked obstruction of the air-way which they believed to be due in part to spasm of the bronchial musculature. Failing to relieve this by intravenous use of atropine, although the inhalation of stramonium fumes was consistently successful, they concluded that the bronchial circulation had been obstructed to such a degree that the muscle could be reached by local application only. This is of great interest in connection with circulatory obstruction in those severely gassed with chlorine. Hill (20) found that bromine vapor in a 1-1000 concentration killed the mucous membrane of the trachea so that it might be stripped off by violence of the respiratory efforts and be drawn into the larger bronchi, forming a tree-like cast which suffo-

cated the animal. In general, bromine resembles chlorine in its action, but is much more irritating to the conjunctiva and the mucosa of the upper respiratory tract, while there is reason for believing that the pulmonary changes are not quite as marked. If used in warfare as a shell gas, the well known cutaneous lesions would be an important part of the pathological complex.

HYDROCYANIC ACID. HCN . Clear liquid, boiling at 26° . Density as a gas, 0.948 compared to air. Hydrocyanic acid is being used intensively as a shell gas. Its boiling point is such that it is well adapted to this use. Its direct and immediately lethal toxicity as well as the practical absence of anatomic lesions are well known, and its use in warfare has thus far produced nothing new in this regard.

HYDROSULPHURIC ACID. H_2S . Colorless gas of characteristic odor. Density compared to air, 1.191. Gaseous at all ordinary temperatures and pressures. Other than reports of its use, little information in regard to poisoning with hydrosulphuric acid gas has appeared in the war literature. Filippini (64) says that death may follow its inhalation at a concentration of but .07-.08 per cent, if continued for some time, and that 1.5-2.0 per cent is rapidly fatal.

PHOSPHINE. PH_3 , density 1.214, and **ARSINE**, AsH_3 , density 2.695, have both been used in warfare. The lethal concentration of the former is given as 0.025%. It kills directly by virtue of its own toxicity. In addition to its use as a weapon of offense, arsine assumes some importance as a source of accidental gassing. This possibility in connection with the generation of hydrogen for filling balloons has already been mentioned. It has also been reported as one of the many hazards to which the crews of submarines are exposed. In arsine gassing, death is usually delayed, occurring from the second to the sixth day. Extreme hemolysis, icterus, haematuria and prostration dominate the clinical picture.

SULPHUR DIOXIDE. SO_2 . Density, 2.21. Sulphur dioxide is easily liquefied by cold and pressure and has been used, according to Lung (31), in hand grenades, filled with the liquid and provided with a small bursting charge to scatter the contents when thrown. It is a respiratory irritant and in sufficient concentration produces pulmonary lesions and asphyxia. It is not effective unless comparatively concentrated and apparently has not been much used as it is mentioned by but a few authors.

NITROUS FUMES. N_2O_3 , nitrous anhydride, density 2.63; and NO_2 , nitrogen peroxide, density 1.57. In the first few months

of the gas attacks many writers believed, probably incorrectly, that the oxides of nitrogen were being used. There was little to support this view and nitrogen compounds are too valuable to be used in this manner, but the oxides are nevertheless important as detonation gases from many of the high explosives now used. This hazard is also met with in civil life as described by Watt and Irvine (51) for the Transvaal mines, where burning blasting gelatin produces these fumes. One of the most characteristic features of nitrogen peroxide poisoning is its delayed action. Hill (20) calls attention to the fact that firemen exposed to the fumes of nitric acid are unaffected at the time but develop a fatal inflammation of the lungs during the next twelve hours. Gassing with nitrous oxides as it occurs on board ship is discussed by Ohnesorg (72) in a review of the work of Esch. There is usually a little headache, cough and tightness of the chest which soon passes off. Then in six to eight hours there is dyspnoea, cough, bloody serous expectoration and death from asphyxia and heart failure occurs in about forty-eight hours. At autopsy there are found pulmonary congestion, oedema, and marked inflammation of the mucosa of the trachea and larger bronchi. A bronchiolitis obliterans may develop in the lungs of those not fatally gassed.

CARBON MONOXIDE. CO. Density, 0.9678. Like nitrous fumes, carbon monoxide was thought by many to have been one of the gases used in the early attacks. Its lightness and the fact that it can be liquefied only by extremes of temperature and pressure make it entirely unsuited to use as either a cloud or shell gas. Its importance, as mentioned above, is due to its production in enormous quantities as a detonation gas. Readily diffused in the open, it becomes exceedingly dangerous when encountered in military mining. It can be readily detected, even in minute quantity, by the use of mice or canary birds, which are susceptible to about 0.05 to 0.06%. Breathing of otherwise normal air containing 0.2% of CO for several hours will usually cause death and 0.1% may be fatal through cumulative action. Basing his report upon cases due to carbon monoxide gassing in military mines Sundell (80) gives a very good description of the clinical picture. The premonitory symptoms are heaviness and loss of power in the limbs and giddiness or light-headedness. The loss of power of the extremities may be so marked that the victims are unable to escape although conscious that they are being overcome, or they may fall from the ladders in trying to climb out of the mine. He notes that these men usually show pallor rather than the classical pink color. Vomiting is an almost constant

symptom and headache usually comes on when the men are brought out to the fresh air. In the non-fatal cases this is a very persistent symptom. At autopsy the chief, and often the sole, lesions are punctate cerebral haemorrhages sometimes with ecchymoses in the meninges. Through this finding, the pathology of carbon monoxide poisoning makes contact with that of shell shock, the occurrence of similar haemorrhages in shell shock having raised the question of a common etiology. This problem has been investigated by Mott (98) and others.

CHLOROPICRINE, ACROLEINE, DIBROMACETONE, METHYL-CHLORO-SULPHATE and probably other organic compounds (Vaughan (106), Filippini (64)) have been used for their lethal effect. The literature as yet gives no detailed discussion of their pathology. In general, they are irritants to conjunctival and respiratory mucosae and probably produce an asphyxial death through pulmonary oedema.

BROMIDE OF BENZYL, MONOCHLORACETONE, BROMACETONE, IODACETONE, BROMACETIC ETHER, IODACETIC ETHER, and other compounds are used primarily for their lacrymatory effect. Between this group and the preceding no sharp line can be drawn. The lacrymatory gases are usually liquids at ordinary temperatures and are scattered from shells and hand grenades. The heat of explosion probably suffices to vaporize the liquid as the boiling points of most of these substances range between 110° and 130° (Filippini (64)). Concentrations of some of the bromine compounds as low as one part in several millions are said by Hill (20) to render men ineffective through lacrymation and photophobia. There are several articles dealing with the lesions produced by unidentified members of this group but this is otherwise an unworked field. Trémolières and Loew (1) report upon five soldiers gassed with shells which gave off a heavy, acrid, suffocating yellowish smoke. They felt a severe smarting compelling them to close their eyes, and sharp pain in the throat with violent cough. They felt stupefied and two lost consciousness. In the open air, they revived but continued to have constant lacrymation and photophobia. After several hours sight was obscured and they believed themselves blind. Three had watery greenish vomitus. When seen about thirty-six hours after gassing there was intense congestion of bulbar and palpebral conjunctivae, constant lacrymation and a marked opacity of the cornea so that fingers could be counted only with great difficulty. Purulent bronchitis and broncho-pneumonia developed. There was constant cough and the greenish yellow purulent sputum was often blood streaked.

All suffered profound psychical and physical depression. The blood count showed the red cells moderately reduced in number, the leucocytes increased. There were some nucleated reds and coagulation was rapid. At no time were there albumin, sugar or bile pigments in the urine. These patients all recovered, the lung signs clearing up in ten days to three weeks and eventually the corneal opacity likewise disappeared, leaving normal vision. The authors note the reduction of the red blood cells without haemoglobinuria or haemolytic icterus as an interesting feature of these cases. Agasse-Lafont and Roux (82) report another group of cases gassed by an unidentified lacrymatory gas. All of the five men under observation had persistent vomiting after each meal for several days and then developed all the symptoms of gastric erosion or ulcer. One vomited blood on two occasions. Another had melaena and the erosion seemed to be in the duodenum. Gastro-enterostomy was done in this case and all symptoms subsided. These case reports suggest vascular or haemic changes similar to those found in phosgene gassing.

“MUSTARD GAS,” DICHLORETHYLSULPHIDE. The so-called mustard gas has been in use by the Germans since July, 1917. It is used entirely by means of shells and is scattered in liquid form by the bursting charge. It requires special mention since it produces the most severe chemical burns as well as being lacrymogenous and a respiratory irritant. The following data are largely taken from Mandel and Gibson (95). A slight odor of mustard is experienced at the time of gassing but little else. After a free period of from four to sixteen hours, during which the patient usually continues his duties, there is epigastric distress and violent vomiting. The cardinal symptoms are (1) conjunctivitis, photophobia and lacrymation,* (2) irritative laryngitis and bronchitis, persistent cough, serous to haemorrhagic expectoration; (3) burns of hands, face, genitals, buttocks, shoulders and back. In the less severe cases, the skin may be merely pigmented, brownish black, and harsh to the touch. Later this will be followed by desquamation. More often there is distinct blistering with vesicles varying in size from that of a millet seed up to 4 or 5 inches in diameter. Second degree burns are not uncommon. (Through a personal communication the writer has learned of a chemist who received a deeply sloughing burn from a drop of dilute solu-

* The purified redistilled dichlorethylsulphide has less lacrymatory effect than is described for its use at the front. It is not unlikely that it has been employed in mixture with gases which are primarily lacrymogenous.

tion of this liquid running across the back of the hand although the accident was observed and the hand promptly washed.) In severe cases of gassing with "mustard gas" death may occur early from pulmonary oedema. Bronchopneumonia is the most common complication. Albuminuria is not uncommon but true nephritis extremely rare.

From this survey of the literature it will be seen that the pathology of gassing, particularly as applied to the chemical warfare of the past twelve months in which little known organic compounds play the chief part, has yet to be written. The action of each of these organic compounds is a problem in itself which can be properly approached only from the experimental standpoint. The rapidity with which this is done may be the limiting factor in developing a rational therapy.

The accompanying bibliography comprises as far as possible all the important titles on gassing in modern warfare including those which deal with prevention and treatment as well as with symptomatology and pathology. About sixty titles have been omitted. These are chiefly editorial notes, short reviews or popular articles of no scientific value. On the other hand, about fifty references not found in the bibliography distributed from Washington are included in this list.

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"SOME OF THE NEWER CHLORINE DISINFECTANTS"

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The great world war, which is shaking human society to its very foundation, is also jarring one of the corner stones of modern surgery. Up to the present upheaval, the teaching that infection, once it had entered a wound, could not be destroyed by chemic means had become an accepted dogma of surgery. Faith prevailed in the healing power of nature and fear that chemic agents capable of harming the microbes would do still more damage to the infected tissues. So little was expected from antiseptics that Sir Almroth E. Wright in his address on "Wound Infection" (91), delivered in 1915, said: "If it were ever to come about that an antiseptic sterilized a heavily infected wound, that would be a matter to announce in all the evening and morning papers." And just then, according to Carrel, the miracle happened; for he writes (13, p. 10) "From the month of September, 1915, it has been possible to do away with suppuration in hospitals."

Like all innovations, the attempt to really disinfect a wound by means of chemotherapy has met with enthusiastic acceptance as well as with scepticism. When Carrel and his associates first presented their views on wound disinfection (10), "the method that might have saved a large number of limbs was rejected with culpable levity," says Carrel (13, p. 10). "The men who criticized us so severely have neither taken the trouble to examine our methods or to check our results. They knew nothing of the method they discussed."

One would hardly feel justified in saying this of Sir Berkeley Moynihan, who believes (68) that the Carrel method "achieved its greatest successes in cases in which it need never have been used."

A. U. Desjardins (42) divided the patients into groups of ten, and treated each series with a different antiseptic solution, such as Dakin's, Wright's hypertonic saline, iodine solutions of different strengths, acetic acid solution, and bicarbonate solution, with control cultures twice a week. The results failed to show any distinct difference in the power of the different antiseptics used to shorten infection and hasten granulation—when the wounds were properly drained the infection soon subsided—but they did show that continuous irrigation, while of distinct

value during the active suppurating stage of the wound, should then be discontinued and dry dressings substituted.

On the other hand, Carrel has succeeded in gaining a large number of converts for his method. Thus, Tuffier (86), who as medical inspector had an unusual opportunity to compare the effects of treatment, expressed his preference for Dakin's solution. He concludes that the hypochlorite method, when properly applied, would prevent a large proportion of the after-results which are so apt to follow wound infection. Surgeon General Sir Anthony Bowlby (8) finds the hypochlorite treatment more useful in war wounds than any other application yet tried. He said this in 1915. That he still believes in the method, is shown by the fact that he was willing to write an introduction to Carrel and Dehelly's book (13), in which he says: "The whole practice of war surgery has been improved by Dr. Carrel's confidence that antiseptic treatment can sterilize a septic wound, and that it does so if sufficient care and skill are bestowed upon it; and the lesson he has taught was very necessary."

Among the many others who endorse this method, may be mentioned Dalton (36), Gibson (52), Lyle (61), Rowe (74), Sherman (77, 78), Uffolz (87). Professor Arthur Dean Bevan (5) raised a storm of protest when he expressed his opinion that: "Looking at the problem in a broad way, if we could express in figures the value of the means at our disposal of treatment of the shell and rifle wounds of this war, certainly much more than 90 per cent of the sum total of the value of wound treatment would consist in the proper employment of the well known and generally accepted rules of surgical technic. Granted that the remaining 5 or 10 per cent depended on the proper employment of antiseptic solutions, one may be very sure that the choice of one of a half dozen thoroughly tried out antiseptics, such as boric acid, aluminum acetate, Dakin solution, dichloramin-T, hydrogen peroxid, phenol, and iodine, would not make any enormous difference in the sum total of the end-results. If the above statements are true, it would be a serious mistake for the government medical services to adopt the Carrel treatment as a great and wonder-working improvement in our surgical technic, and to force a complicated, time-consuming and expensive plan of treatment on our medical service, possibly to find within a short time that it is of little or no value." Witness the replies by Welch (90), Bloodgood (6), McCormack (62).

Though majorities and committees are not always safe guides to scientific truth, some weight might be attached to the

report (18) of the special committee appointed by the director-general of the British Army Medical Services for the purpose of investigating and reporting on the Carrel-Dakin treatment of wounds. The following sentences characterize the conclusions of the committee: "While convinced that the use of Carrel's tubes, as the committee saw them employed, is a very valuable means of applying an antiseptic fluid to a wound, the committee is not satisfied that Dakin's fluid is markedly superior to eusol, and was prepared to find that other antiseptics can be used with advantage by the Carrel method. The results of the Carrel-Dakin treatment, as seen in a large series of unselected cases, were remarkably good. The most striking evidence of the value of the treatment, seen by the committee, was a printed notice put up in a prominent place in Tuffier's ward: '*Tout blessé qui suppure a le droit d'en demander la raison a son chirurgien*' ('Every patient whose wounds suppurate has the right to demand an explanation of his surgeon'). It seems then that Carrel is right, and that it is possible to 'do away with suppuration in hospitals.'"

Regarding the problem presented by the treatment of infected wounds, Carrel and Dehelly (13) have this to say: "Destruction by chemical means of the microorganisms infecting a wound is rendered possible by the different resistance presented by the tissues equipped with a circulation and microorganisms which are found on the surface." That such difference of resistance exists has been abundantly proved by the success of Crede's prophylaxis of ophthalmia neonatorum. Inasmuch as the infection of war wounds is at first and for some time afterward always strictly confined to the surface of the wound, the important thing to do is to destroy the microbes before they have invaded the tissue or to keep them from proliferating, without harming the tissues. Carrel, however, also believes that even in wound infection of long standing a great deal can be accomplished by proper chemotherapy. In no case is mere application sufficient. *The agent must not only be strong enough but applied long enough; and the innermost recesses of the wound must be laid open, so as to present an actual surface.* This, it seems to the reviewer, is the gist of the Carrel method. It is most especially the failure to allow these agents to act for a sufficient length of time that was responsible for having cast discredit upon them. If we are witnessing a real renaissance of Listerism, it will be because chlorine is much less toxic than phenol; for phenol and other toxic antiseptics cannot be applied for a time long enough to accomplish the result, owing to inevitable poisoning from absorption.

That the method is not entirely satisfactory, is admitted by its originators. Its chief disadvantage is that it is complicated. Numerous are the attempts at simplification of technique, some of which refer to improvements in the physical method of carrying out the treatment, e. g., Dimond and McQueen's apparatus (43), or modifications in the form in which the chlorine is applied, (to be discussed below), or substitution of other agents for the chlorine. The important fact remains, however, that, no matter what the fate of the details of the method, a principle of transcendent significance is at stake, namely whether it has actually come about that, to use Sir Almroth Wright's previously quoted phrase, "an antiseptic sterilizes a heavily infected wound."

Though it is possible that some other agent be found to supersede chlorine, it is not very probable; for there is no other body at present in view that combines such powerful germicidal action with such harmlessness of end products as this halogen. The substances to be discussed below may be looked upon as merely administration forms for this agent.

HYPOCHLORITE PREPARATIONS.

History. Dakin, in an article on "The Ancient History of the 'New Antiseptic'" (25), brings out the following interesting facts. In 1788, Berthollet (4) obtained a liquid of bleaching and disinfecting qualities by the action of chlorine upon alkalis. In 1792, four years after Berthollet's discovery, potassium hypochlorite was made on a commercial scale by Percy at the Javel works near Paris, by passing chlorine into crude potashes. The product was sold as *eau de Javel*; and its use as a disinfectant advocated by Berthollet and by Guyton de Morveau. (The *eau de Javel* at present sold in France is, however, usually sodium hypochlorite and not the potassium salt.) In 1820, Labarraque (59), who was pharmacist, first to the Emperor and later to Louis XVIII, prepared a fluid similar to Berthollet's by the action of chlorine on an aqueous solution of sodium carbonate. This fluid became known as *Liquueur de Labarraque* or Labarraque's Disinfecting Fluid, and acquired considerable fame by being used successfully for the embalming of the corpse of Louis XVIII, which had become so decomposed that nobody would venture near it. Later the more stable calcium hypochlorite replaced the sodium and potassium salts, and the fluids were prepared by decomposition of the calcium salt with carbonates or sulphate of the alkali metals. In 1834, Ballard (2) discovered

hypochlorous acid, and determined the composition of Berthollet's fluid to be a mixture of sodium chloride and sodium hypochlorite. In 1846, Semmelweiss freed his clinic from an epidemic of puerperal fever by means of hypochlorite. Since then hypochlorite has been used as an antiseptic with more or less satisfaction, e. g., by Mitchell (66), Sandeman (75). The irritant and even caustic properties of these preparations militated, however, against their more general employment.

At the beginning of the present war, investigations were undertaken, apparently independently of each other, in two different research laboratories, having in view the discovery of the best disinfectant for war wounds; and both groups of investigators decided upon hypochlorite as the one most promising.

EUPAD AND EUSOL. At the University of Edinburgh, Smith, Drennan, Rettie and Campbell (79), encouraged by the high phenol coefficient assigned hypochlorite by Rideal (72), and in spite of Andrewes and Orton's (1) apparently unfavorable conclusions, undertook experiments which seemed to assign to hypochlorous acid a superior germicidal power than was inherent in the alkali hypochlorites. They therefore attempted to obtain free hypochlorous acid by the action of boric acid on chlorinated lime; to a mixture of equal parts of which they gave the name "Eupad," obtained from the initials of Edinburgh University Pathological Department, thereby setting a new precedent in the coining of names. A solution made from this, by adding 25 gm. to a liter of water and filtering after several hours (called by them "Eusol") they found to contain 0.27 per cent of free hypochlorous acid (not 0.5 per cent as originally published (80)), and to remain effective for almost a month. They have just published a more convenient method for preparing small quantities of Eusol (82).

Eupad has not met with favorable results as dusting powder for wounds. Thus John Fraser writes (49) that eupad produces a stinging or burning sensation, which lasted about 30 minutes, and that its early application seemed to retard wound secretion. Bowlby (8) finds that powders are liable to obstruct drainage. While producing more irritation at the point of contact, powders are not nearly as penetrating into the deep recesses of wounds as are aqueous solutions. Evidently an improvement upon eupad as a dusting powder for wounds is the formula advocated by Vincent (88,89): Calcium hypochlorite, 1 part; Boric acid, 9 parts. This powder is applied at once, after thorough mechanical cleansing, by pouring it freely into all crevices of the wound. Vincent has found it a most potent prophylactic of infection in

military practice, and perfectly tolerated by the tissues. He believes that it favors cicatrization.

Eusol was found by Fraser (49) to be painless, when used as a moist dressing, and to have yielded extraordinarily good results in gas gangrene. The special committee (18) for the investigation of the Carrel treatment is "not satisfied that Dakin's solution is markedly superior to eusol."

DAKIN'S SOLUTION. Finding Labarraque's too irritating when used for the disinfection of wounds, Dakin (23,24) endeavored to lessen the irritant qualities of the solution by neutralization of the alkali necessarily present in Labarraque's solution, owing to hydrolytic dissociation of the hypochlorite and the further liberation of alkali when the chlorine of the hypochlorite attaches itself to the nitrogen of the protein. To effect this neutralization, Dakin made use of the property of polybasic acids to keep their essential neutrality even after addition of acid or alkali. Such a one is boric acid, which though an acid dissociates so feebly as to be devoid of irritant qualities, and yet is capable of neutralizing alkali. The result was the "Neutral Solution of Chlorinated Sodium (Dakin's Solution)," about which so much has been written of late. Inasmuch as the solution is, however, still alkaline to litmus (cf. book review (14) and Dakin's reply and the reviewer's rejoinder (27)), it is a question whether the solution should bear the name "neutral."

Dakin's Solution, as originally prepared was not entirely satisfactory, however. Sometimes it worked admirably, at other times it did not. It was Daufresne who pointed out that the variation in results was due to variation in the amount of available chlorine in the chlorinated lime, which ranges from 20 to 37 per cent. He therefore proposed that the chlorine content of each new lot must be estimated, before concordant results could be obtained. He showed that a solution containing 0.45 to 0.5 per cent of hypochlorite does no harm to the tissues and sterilizes wounds, while a solution below 0.45 per cent is not sufficiently active and one above 0.5 per cent is unnecessarily irritating. He also determined that a mixture of sodium bicarbonate and of sodium carbonate in certain proportions enabled one to dispense with the use of boric acid in the preparation of the solution, thereby lessening its irritant action and improving its keeping qualities. These various modifications of Dakin's solution by Daufresne have been adopted by Carrel and others. The formula for the preparation of the *Dakin-Daufresne solution* can be found in numerous places, e.g., references 13, p. 75; 31, p. 26; 12.

The solution prepared by the process contains 0.475 per cent of sodium hypochlorite, and is but slightly hypertonic, its freezing point being: $\Delta = -0.60$ to -0.65 .

Potherat (70) did not believe that an essential difference existed between Dakin's and Labarraque's solution. Daufresne (37) demonstrated the difference in destructive action of Dakin's and of Labarraque's solution by the following simple experiment. Fragments of dead skin placed in Labarraque's solution, diluted to equivalent strength, show swelling and corrosion within two hours, and complete disintegration of the tissue within fourteen hours, while pieces of skin in Dakin's solution showed practically no maceration in two hours and, at the end of twenty-four hours, no more change than was produced by the other solution within two hours. Nevertheless, the solution is still powerfully germicidal.

Numerous other modifications of the formula for Dakin's solution have appeared. Thus F. Rosengarten publishes a "Simplified Method for the Preparation of Carrel-Dakin Solution" (73). McClendon (63), on the other hand, greatly increases the complexity of the solution by attempting to make it as "physiologic" as possible. Thus he advocates that the salts of the fluid should be so balanced as to approximate serum in its diffusible constituents as closely as possible, using therefore a modification of Ringer's solution. It should be isotonic with the blood. Dakin's solution is hypertonic. The hydrogen-ion concentration should be so adjusted that the PH of the fluid does not exceed the limits of 5 to 7.5; the extreme limits of variation of the PH that are compatible with life being from 5 to 9. The fluid may be chlorinated by passing chlorine gas through it; and finally titrated to bring its strength to that recommended by Carrel and Dakin. Fluid made with these precautions has been tried on large wounds of dogs and men; but McClendon admits that "not sufficient data have been collected to show that these precautions are really always worth the trouble; but, on the other hand, no disadvantage of such solution has been noted." Electrolytic preparation of the solution is advocated by Beattie, Lewis and Gec (3); but Dakin considers electrolytically prepared hypochlorite solution peculiarly unstable, and only useful where it may be conveniently prepared fresh daily or, at least every two or three days. Dakin and Carlisle (28) describe, in detail, the electrolytic preparation of hypochlorite solution, as it may be advantageously carried on in ships (see also reference 31, p. 116). Magnesium hypochlorite has been advocated by C. Meyer (64).

Wilfred G. Fralick (48b) claims having prepared an isotonic hypochlorite solution in 1902 by passing chlorine gas into a *cooled* aqueous solution of sodium hydroxide, and advises neutralizing the solution by a few drops of hydrochloric acid until litmus paper does not turn in color when introduced into the liquid. He has found that this solution may be stabilized by adding a very small quantity of a potassium permanganate solution. He considers his solution so well balanced that when the hypochlorite has been decomposed by the destruction of toxins, bacteria or other organic matter, physiologic salt solution remains as a final product. He has never observed more than slight irritation from its use on the most delicate tissue, even when used intraperitoneally. He reports an experiment (48a) on two dogs in which huge intravenous injections, amounting to 24 and even 50 per cent of the total blood volume, of isotonic sodium hypochlorite solution were made after preliminary withdrawal of 20 to 40 per cent of the blood, with no untoward results and recovery of the normal blood count within a few weeks followed by an increase of the number of red blood corpuscles to above the normal in the succeeding weeks with a gradual return toward the normal.

Effects of Hypochlorite Solutions. (a) Germicidal qualities. The two most important things to realize regarding the antibacterial properties of the chlorine disinfectants is their extraordinary dependence upon the composition of the medium, and the comparatively brief duration of their action. For the disinfection of water chlorine is so efficient that it is now practically exclusively used for the purification of water on a large scale. As little as 0.5 to 1 part of active chlorine per million parts of water is sufficient to cause almost complete disappearance of organisms of the *B. coli* group; though spore bearing forms, which however are of little hygienic importance, are not much affected. While 1:500,000 of hypochlorite will sterilize water, 1:3,000 is required for the sterilization of broth (1), and 1:1,500 to produce the same result in 50 per cent horse serum (31). The difficulty of sterilizing pus has been shown by W. Parry Morgan (67), who found that it required 1:800 of available chlorine either in form of eusol or of Dakin's solution to sterilize pus, when pus and disinfectant were mixed in the proportion of 1 to 9. The difficulty of sterilizing blood is still greater. Using a blood medium similar to that suggested by Emery (45), it was found by Dakin (31, p. 94) that, even when two volumes of 0.5 per cent sodium hypochlorite or of eusol were used to one volume of blood

infected with staphylococci, complete sterilization was not quite accomplished, although considerably over 99 per cent of the organisms were killed. These studies emphasize the necessity for the use of a large excess of the disinfectant fluid, precisely such as is employed in the Carrel technique.

Like other germicides, chlorine is not equally efficient against all forms of microbial life. Thus Schütze (76) found that no direct lethal effect could be expected upon spores as resistant as those of malignant edema embedded in the tissues of a wound, unless by irrigation the serous fluid surrounding those spores could be replaced to well above 95 per cent by the hypochlorite solution. K. Taylor (85), finds that "Dakin's solution showed a moderate activity against the staphylococcus, was nearly inert against the *B. pyocyaneus* and the gas bacillus but was more active against the streptococcus." His clinical experience (84), showed a decided superiority of 1 per cent acetic acid as a dressing for pyocyaneus infected wounds over hypochlorite or other antiseptics used in the same way.

It must ever be remembered that the duration of action of the hypochlorite in contact with the tissues of the wound is short, ceasing the instant the chlorine has attached itself to the organic material. This is why mixture of pus and hypochlorite kept for some time are found to be good culture medium for microbes. Pierre Delbet (41) found wound secretion mixed with Dakin's or Labarraque's solution a better culture medium than without it. Hence the necessity for the continuous irrigation of the wound with the solution; or, if that be impracticable, intermittent instillation at comparatively short intervals, using on an average about 10 ml. every hour or two for an ordinary wound.

(b) *Solvent Action.* Another important property of these solutions is their power of dissolving necrotic material, without destroying living tissue supported by its circulation. The reason for this difference in resistance may be due to a phenomenon to which Guillaumin and Vienne (55) call attention; the inhibition of the swelling of tissue in alkaline solution when salt is present in the liquid. A piece of skin immersed in 3 per cent solution of sodium hydrate swells up and becomes transparent, while a similar piece of skin immersed in a 3 per cent solution of sodium hydrate to which has been added 12 per cent of sodium chloride shows no change. The solvent action upon dead material favors the cleaning up of the wounds and lessens the pabulum for microbes. It brings, however, the danger with it that clots

temporarily closing vessels may become loosened and that secondary hemorrhage may occur. Hence it is necessary that reliable hemostasis be secured before the solution is employed.

(c) *Deodorant and Detoxicant Effect.* Hypochlorite not only destroys microorganisms and necrotic tissue, but also the offensive odor of wounds; and, what is more important, it decomposes poisons contained in pus and renders them harmless. This was shown, for instance by A. Lumière, (60), who found by injection into animals that candle-filtered pus could be deprived of its toxicity by treatment with hypochlorite. This is probably the reason for the rapid improvement of the general symptoms in patients suffering from extensive abscesses, when these are treated with hypochlorite solution. Dean and Adamson (39) used eusol to reduce the toxicity of an emulsion of *B. dysenteriae* (Shiga) to be employed for immunizing purposes; and obtained by injection of such vaccine a satisfactory degree of immunity.

That Dakin's solution is not entirely free from irritant action upon the tissues, is evident from the fact that it is found necessary to protect the skin surrounding the wound against the liquid, by means of petrolatum impregnated gauze. Carrel and Hartmann (15) and Lecomte Du Nouy (44) studied the effect of hypochlorite solution upon the cicatrization of wounds and arrived at the conclusion that, while the solution possessed no power of accelerating the healing of an aseptic wound, it decidedly hastened the healing in the presence of infection. Carrel, as a result of his experiments, feels confident that the solution does not have more than a slight retarding effect upon the repair of aseptic wounds, an effect so trifling as to be negligible in practice.

While Dakin's solution is practically non-toxic when applied to the surface or even when injected subcutaneously, it is very dangerous when injected intravenously. Thus 10 ml. of this solution injected into the marginal vein of a large rabbit rapidly caused death. This Carrel ascribes to the hemolytic qualities of the solution. That the intravenous injection of Fralick's hypochlorite solution was not very harmful to dogs, even though he infused 600 ml. in a 15.6 kg. animal, is shown by his experimental protocol (48a). Eusol has been used intravenously by adding 8.5 gm. of sodium chloride to a liter of the solution. Having found that as much as 25 and even 45 ml. can be injected intravenously into rabbits, an amount equal to a quarter or half of the total blood volume, Smith, Ritchie and Rettie (81) injected 100

ml. of eusol in normal saline at 37°C. in the course of five minutes into a patient suffering from septicemia. After a second injection twenty-four hours later, the patient recovered. Brand and Keith (9) and Fraser and Campbell (51) report similar cases. Raúl Flores Córdova (19, 20) reports experiments that seem to show that intravenous injection of eusol can save animals from lethal doses of diphtheria toxin, tetanus toxin, staphylococcus, and bacillus perfringens. Dakin (26), on the other hand, feels confident that hypochlorite solutions when injected intravenously in quantities similar to those employed for therapeutic purposes cannot exert any appreciable direct germicidal action. The hemolysis produced by large doses might possibly have an indirect affect.

It may be noted incidentally that eusol irrigations had been used with alleged success in the treatment of dysentery by Crean (21). The solution diluted with an equal amount of hot 2 per cent saline was borne without pain. Jefferson (57) found that eusol diluted to one-fifth strength gave satisfactory results when used three times daily by irrigation in the treatment of conjunctivitis. The aggregate time required to cure 50 cases by means of this treatment being 303 days, as compared with 448 days under boric acid and zinc sulphate treatment.

CHLORAMINES.

Dakin (29, 30) and his associates believe that the action of hypochlorites upon proteins depends upon a chemical reaction similar to that which takes place between ammonia and hypochlorite, which results in the production of chloramine. Rideal (71) and others had previously pointed out the probable formation of chloramine during the sterilization of sewage by hypochlorite. That the germicidal action is due to this reaction is rendered probably by the observation that, while the free halogens differ but slightly in their bactericidal power, and while hypochlorite differs but slightly from chlorine, hypobromites and hypoiodites possess feeble germicidal capacity, which coincides almost exactly with their feeble capacity for reaction with proteins and amino-acids. Inasmuch as chloramines and bromamines destroy bacteria at a lower concentration than the corresponding hypochlorite and hypobromite, it must be assumed that the combination increases antisepticity. Compounds of high antisepticity are also formed when proteins such as blood serum, egg albumin, or casein are treated with hypochlorites. The antisepticity ceas-

es, however, when the chlorine has become combined with the carbon.

Considerations such as these led to a study of the chloramines, from among which were chosen toluene-p-sulphondichloramine, for which Dakin devised the abbreviated name Dichloramine-T, and its sodium derivative, for which the name Chloramine-T was adopted. These substances had been prepared by Kastle, Kaiser and Bradley (58), in 1896; and further studied by Chattaway, (17). The difference between the two is chiefly one of solubility: chloramine-T is water-soluble, dichloramine-T is lipid-soluble and insoluble in water.

CHLORAMINE-T is a fairly stable white solid of faint chlorous odor and bitter taste, freely soluble in water; its saturated aqueous solution containing about 15 per cent of the salt. It is faintly alkaline in reaction, non-corrosive, though very irritant in strong solution, and does not coagulate proteid. Its stability is its chief advantage over the hypochlorites. While but slightly toxic, Dakin has found it as powerful a disinfectant as an equal weight of hypochlorite. H. C. Hamilton (56) assigns to it a phenol coefficient of 50. Dakin states that, when it is used in strength of less than 0.2 per cent, it does not interfere with the rapidity of repair. A solution of 2 per cent may however delay or even arrest cicatrization. Given intravenously, Dakin (26) found that it causes a marked increase of pericardial fluid and commonly edema of the lungs; so that it appears that in large doses it acts as a definite poison to the endothelium.

The 2 per cent solution of this substance, which Dakin considers decidedly more potent than the sodium hypochlorite solutions usually employed, may be used for the irrigation treatment of wounds by the Carrel method. As such solution is slightly hypotonic, normal salt solution should be used as diluent, when an isotonic fluid is desired. The eye tolerates 1:1000, while 1:500 is decidedly irritant. Chloramine-T has been used as a nasal spray in 0.5 per cent solution for the disinfection of meningococcus carriers by Gordon and Flack (53); though Dakin finds (31, p. 101) that such spray for less than 15 minutes was not very effective and that frequent repetition of the treatment was desirable, which however is a rather severe procedure. He prefers a dichloramine spray for the purpose. Fildes and Wallis (46) conclude that none of the antiseptics tested by them, including chloramine-T, had any conspicuous merit in the disinfection of meningococcus carriers. In cystitis, the tolerance often appears to be less than in the eye. In chronic urethritis, on the other hand, 1:500 can be

used for the initial injection, and the strength increased subsequently.

Dakin advocates a 5 per cent chloramine-T gauze used dry for light packing as a first application to fresh wounds, to prevent progress of infection. Where frequent renewal of the antiseptic or irrigation is called for, the gauze is superfluous.

As none of these bodies can be used in fatty ointments, Daufresne (38) devised a paste of the following composition:

Chloramine-T	10
Sodium Stearate	70
Water	1000

Mixed to a homogeneous paste, best by a mechanical mixer. Carrel and Hartmann (16) found this paste useful for sterilizing moderately infected wounds and for maintaining asepsis in wounds already sterile.

DICHLORAMINE-T, a white powder of chlorinous odor, practically insoluble in water, has been suggested by Dakin and his collaborators (35, 83) as a means of overcoming the two objections of the chlorine compounds just discussed; namely instability of solution, so that the compound loses its effect soon after having been applied to the wound, hence requiring frequent and therefore troublesome reapplication; and irritation of the skin on prolonged use. Inasmuch as this substance, when dissolved in organic solvents, gives up a portion of its chlorine to these liquids, Dakin advises that the solvents—oil of eucalyptus and liquid petrolatum—be chlorinated before the dichloramine-T is added. A 6.5 to 10 per cent solution in a mixture of chlorinated eucalyptol and petrolatum, (for the preparation of which directions are given by Dakin (35 and 31, p. 37)) gives off chlorine slowly for from 18 to 24 hours; hence does not have to be reapplied more than once a day. After careful surgical preparation of the wound, the liquid is simply sprayed on; or, if the wound be deep, the cavity is filled with the liquid. Only a few layers of gauze should be used to cover the wound, so as to avoid absorption of the oil by the dressing. Among the advantages claimed for this method, as compared with the Carrel-Dakin technique are: simplicity, saving of dressing material, greater rapidity of healing, and the possibility of dependent drainage.

Dakin and Dunham (32) claim they have obtained very satisfactory results in the disinfection of meningococcus carriers by the use of an oil spray containing 2 per cent of dichloramine-T

dissolved in chlorinated eucalyptol and paraffin (1:4), repeated every two to four hours. The first few applications produce sneezing, but tolerance is soon acquired. Simon Flexner (47) endorses this method. Dakin warns against using it in acute coryza, as it is too irritating.

HALAZONE, a name given to Parasulphondichloraminobenzoic acid by Dakin and Dunham (33,34), is advocated by them for the sterilization of small quantities of drinking water, such as are carried by soldiers in their drinking bottles. It is a relatively stable substance, extremely active—1:300,000 being sufficient for the sterilization of water within 30 minutes,—of such slight taste that the amount required still leaves the water perfectly palatable, and it seems practically non-toxic. One of its chief advantages is that it lends itself well to preparation of tablets, each of which it is advised should contain 4 milligrams, one or two of which are sufficient to sterilize drinking water within half an hour. It is not suitable for the disinfection of milk or other food.

If all of what has been said in favor of these agents is true, we must conclude that chlorine is the king of disinfectants.

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THE IRRITABLE HEART OF SOLDIERS AND THE HAMPSTEAD HEART HOSPITAL

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Under the stressful conditions of modern warfare, in which exposure to the continuous fusillade of our own and the enemy's guns is combined with the depressing influences of the cold, darkness and moisture of life in the trenches, it is only natural that the soldier in the field should suffer greatly in that most delicate part of his body mechanism, his functional nervous system. Even the strongest men cannot endure the hardships of the firing line for long without respite, and a continuous relief system whereby the men in action are withdrawn to rest-billets at short, regularly recurring, intervals, has of necessity been enforced. In spite of all precautionary measures, however, War Neuroses abound both in base hospitals and convalescent camps, and are especially frequent among the men of less robust physique or less stable mental fibre. The differentiation of such functional conditions from organic troubles or from malingering, the treatment necessary for the improvement of the patient and his rehabilitation as a soldier, and the final decision as to his future capacity for duty at home or abroad according to the extent of his cure, are problems which have taxed the best judgment of the Army Medical Service, and their successful solution promises to be one of the triumphs of military medicine in the present campaign.

One of the most important and efficient measures that has been taken by the British War Office with this end in view, has been the organization of special hospitals under the care of medical experts, and especially equipped, where disorders of various kinds can be studied, classified and treated in a properly scientific manner. Notable examples are the Ramsgate Hospital for Nervous Disorders at Ramsgate, the Bramshott Eye Hospital, and the Military Heart Hospital at Hampstead in London.

It is with this last named institution and with the class of work done there and in the Cardiac Department of other Military hospitals in London, that we are concerned in this communication. Early in the second year of the War the attention of the public was drawn by leading articles in the London Times and in British medical periodicals, to the large numbers of soldiers who were being invalided home from the Front by the now well-

recognized disorder known as Soldier's Heart, in which symptoms of a more or less transient cardiac exhaustion without evidence of organic disease, form the predominant feature. The need of such patients for special study and treatment, and the evident possibility of their rehabilitation under suitable conditions, led to a demand for an investigation. This was opened by the Medical Research Committee of the National Insurance Act, on the initiative of Sir Alfred Keogh in the autumn of 1915, and was entrusted in the first place to Sir James Mackenzie (1), who with Dr. R. McD. Wilson (2), opened a discussion on this subject before the Royal Society of Medicine on January 18th, 1916, and reported the results of observations made by himself in collaboration with Dr. Wilson on 400 cases. He pointed out that the large class of patients under consideration differ essentially from the subjects of organic heart disease both in the milder grade of symptoms, the more favorable prognosis and the form of treatment indicated. In the latter connection he laid down the important principle that complete rest was not advisable except in the early stages, and that fresh air, graduated exercises, recreation and cheerfulness take an important part in the rehabilitation of the patient, so that officers should be sent off on golfing or fishing tours, and light games in out-door surroundings should be provided for the private soldiers, with the one injunction to both that such occupations be carried on only to the point of pleasurable enjoyment and never to fatigue. In addition he stated that the proper investigation and treatment of such cases required the provision of a special hospital with complete equipment and in suitable surroundings.

These views were shared by Sir Clifford Allbutt and Sir William Osler who, with Sir James Mackenzie, organized the new Hospital, and with Major J. C. Meakins and Captain F. C. Cotton of Montreal, and Captain Parkinson were members of its organizing staff. An article in the Times at this time may be abstracted thus: "Sir Alfred Keogh (Director General of the Medical Forces), decided to open a special hospital of a very special kind, and recognizing the value of a bright and bracing situation chose the Military Hospital at Hampstead for the new Heart Hospital. It is fully equipped with bacteriological laboratory, electro-cardiograph with wired connections to the wards, orthodiagraph, and X-ray installment. The Mackenzie ink polygraph is in active operation and individual assistants are giving their whole time to the study of vasomotor reflexes, dermatographic and precise orthodiagraphic cardiac tracings, exercises,

gas-analysis, and other phases of the many problems investigated. Here the scientist and clinician are united, and the mental factor, which means so much, especially in this type of case, is given due prominence. As in all army hospitals military considerations, of course, take first place in the handling of the patients, the cases being as far as possible classified on arrival into those who will be again fit for active service and those who will not. In subsequent treatment the latter class are boarded out of the army, while in the former the myocardium is re-educated by graduated exercises to a point where the definite amount of exertion, such as half an hour's strenuous Swedish drill, or a seven mile route march with a 25 pound pack, can be undergone without symptoms. When this point is reached the men are considered fit to return to their units."

The importance of such a hospital, which was in a sense a departure, can hardly be overrated. By accelerating the return to duty or the invaliding from the Service of the disabled soldier, it meant a saving to the State, and constituted one of the most interesting examples we know, of the remarkable organization that has taken place in this war, of preventive and therapeutic forces for the mitigation of the effects upon our soldiers of the terrible conditions of modern warfare. In this way also the powers of the trained specialists who have placed their services at the disposal of their Country, can be utilized with true economy. Moreover, the establishment of this particular form of heart hospital in England, which may be called the home of graphic methods, under the leadership of men who are themselves leaders of thought in the new school of cardiac pathology, and with the control of a wealth of clinical material consisting chiefly of soldiers suffering from functional disorders of the cardiac mechanism, opened an extraordinarily productive field of study which is bound to bring far-reaching advances in our knowledge of cardiac pathological physiology on the one hand, and its therapeutics on the other.

The Hampstead Hospital was opened in the early part of the winter of 1915-16. After little more than a year's work important results are already in hand, and the literature is enriched by numerous observations along new and suggestive lines. Of these the most valuable are the formation of a definite system of graduated exercises of use both for diagnostic tests and for therapeutic purposes, and the establishment of a definite standard in the reaction both of pulse rate and blood pressure to such exercise tests, and the estimation of present and future cardiac disability along

these lines. In this connection the series of articles published in *Heart* on May 20th, last, "On the after effects of rest-exercises and slight exertion on pulse rate and systolic pressure and the P-R interval in irritable and healthy hearts;" "On the occurrence of hyperalgesia in irritable hearts of soldiers;" and "On the effects of atropine, digitalis, amyl nitrate and pilocarpine nitrate on such cases," are of immense interest (13).

The history of the subject of soldier's heart is as follows. The "Irritable Heart of the Soldier" is no new condition, but was recognized as far back as the American Civil War, when it attracted wide attention. A classical description, corresponding in all respects to the picture as presented to-day, is given by Dr. Hathorn in the *American Journal of Medical Sciences* for 1864, and in the same journal for 1871 Da Costa reviewed the subject upon the basis of a series of three hundred cases collected in a hospital in Philadelphia. The condition is characterized by signs of vasomotor instability, aching precordial pain, a sense of exhaustion amounting often to giddiness or faintness, general malaise, rapid pulse on exertion, slight breathlessness, at times slight oedema of the feet, mental depression, and nervous irritability. There is usually a slight rise of temperature especially at the onset, which is often with diarrhoea and other digestive disturbances.

An interesting discussion upon the etiology of Soldier's Heart has occupied several of the British journals during the past two years. Sir James Mackenzie with W. Bezley Thorne (6), R. McD. Wilson, and others, regarded it as one symptom of a general physical exhaustion, the result in the majority of the cases of a latent infection which becomes active under the effect of strain or shock and produces effects of a toxæmia, which yields to the raising of the resistive powers of the individual by good hygiene, fresh air, and cheerful occupation.

The application of this theory of latent infection to all the cases was disputed by Poynton (7), Morison (8), and others. They pointed out that identical symptoms come on quite suddenly after shell shock and other states in which the predominant feature is nervous or physical strain, and raised the question as to whether, under these circumstances, the shock itself might not generate toxins within the body producing a similar result upon the tissues as those having a true infective origin. In this connection an interesting suggestion has been brought forward by Young, (15), that toxins from the numerous insect parasites

which abound in trench life, and so often infest the soldiers there, may be in many cases an exciting cause.

The fact that chemical poisons, especially nicotine, produce a condition practically identical in the so-called tobacco heart, and that the practice of cigarette smoking is practically universal along the Allied Front, leads to the inference that at least a certain number of the cases of soldiers must be traced to this habit. A careful study to determine the immediate effect of cigarette smoking on healthy men and on cases of Soldier's Heart was made by Drs. Parkinson and Hilman Koefod (12) at the Hampstead Hospital recently upon thirty cases of whom twenty were patients with soldier's heart and ten were normal subjects. The conclusion reached was that excessive cigarette smoking was not the essential cause of most cases of "soldier's heart," but that it was an important contributory factor in the breathlessness and precordial pain of many cases.

Finally, it has been shown (White & Johnston (3), Stoney (5)), that a number of cases of Soldier's Heart present the same symptoms as the early stages of exophthalmic goitre, what may be called a pre-Graves condition of hyperthyroidism and which yields to X-ray treatment of the thyroid gland. When it is remembered that shock or emotion of any kind is a strong predisposing cause of goitre this forms a comparatively small but suggestive group.

The true explanation of the etiology of Soldier's Heart will probably be found to lie in some factor common to all the above mentioned cases which acts within the organism producing analogous states of cardiac and physical exhaustion. Such a point of view was brought forward by Crile (16) in his "Mechanistic View of War and Peace," in which he suggested that latent infection, powerful emotion, physical strain, exaggerated hormonal action, are each and all to be recognized as "activators" which set the pace for an undue transformation of energy leading to alterations in the relation of the volatile and non-volatile acids of the blood and other disturbances of the metabolic equilibrium and chemical changes that constitute fatigue.

It is too early for conclusions on this or even less remote problems, but there can be no doubt that the path of real advancement is being followed at such special hospitals as that we have reviewed here, and that the careful methods that are being applied there and elsewhere in the study and treatment of functional disorders in the wealth of military clinical material available today, have widened already our knowledge very much. The

Profession of the future is likely to be permanently enriched by the results of such organized application, by experts, of the principles of scientific medicine to the problems of the functional disorders of the present war, and students of cardiac pathology and therapeutics will owe an incalculable debt of gratitude to such men as the originators of the Hampstead Hospital, Sir William Osler, Sir James Mackenzie, Sir Clifford Allbutt, and Sir Alfred Keogh.

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EDITOR'S NOTE:—*The Revue de Cardiologie de Guerre* by Weil was not accessible to Dr. Abbott in the preparation of her paper. Weil gives a summary of the French literature upon this subject for the first two years of the War. From this experience he concludes that organic cardiopathies, even those well compensated, do not stand the stress of active service and, therefore, should be placed in the auxiliary service. The myocardial cases are less favorable than the compensated aortic and

mitral valvular lesions, which are, on the whole, fairly well borne, but which, even when compatible with a certain amount of effort, react badly to over-strain and emotion, and are a coefficient of aggravation in the traumatisms and infections of war.

Weil also claims that the differential diagnosis of functional and organic cardiac murmurs can be easily made by a new diagnostic procedure; namely, auscultation of the heart during compression of the eye-balls. There exists normally an oculocardiac reflex. The compression of the eye-balls modifies the heart beat so that it becomes slower by ten beats or more, or rarely accelerated to the same degree. In subjects who show functional murmurs the myocardium is in a state of especial erethism. Under compression of the eyes the accelerated rate (100-120) may drop to 80, 60 or 40 beats. At the same time the functional murmur becomes weakened, inconstant or disappears completely. Organic murmurs, on the contrary, become more intense and precise during ocular compression. Weil claims that auscultation of the heart during compression of the eye-balls is a procedure of great value, as the compression slows the heart and renders it more clearly audible, and, that through the employment of this method it has been possible for them to differentiate easily all heart murmurs.

Weil also regards the static and dynamic tests of Martinet of great value in determining the functional value of the heart, and, therefore, in differentiating the normal weak and erethistic heart. Lian's and Martinet's observations upon functional disturbances of the heart and cardiac neuroses associated with nephritis, infections (rheumatism), tuberculosis, nasal defects, multiple glandular insufficiency, and adrenal insufficiency, are abstracted in Weil's review. "*Les insuffisants cardiaques*" described by Guillet and Boyé fall into the same category. These writers, as well as Lian and Weil separate their hypotensive, tachycardiac, acrocyanotic and instable cases from the cardiac neuroses. Martinet discusses this group of functional disturbances that appear usually suddenly after intense emotion or commotion. They do not follow infections. They develop upon a neuropathic foundation (psychical state, nervous crises, distress, trembling, dyspepsia, instable cardio-vascular apparatus, etc.). Gallavardin discusses the tachycardias of Basedow's disease. Aubertin's article on "*la récupération des faux cardiaques*" is of great value from both military and civil points of view. Finally the relation of cardiac affections to the infections of war (scarlatina, rheumatic fever, typhoid and paratyphoid fevers, bacillary dysentery, enteritis, pneumococcus infection, etc.) has been discussed by Nobecourt, Florand, Carnot, Oppenheim, Minet, Carles, and others. (See references below.) Gouget has studied the bradycardia of fatigue, as well as the relative bradycardia associated with some fevers. To the latter he attributes a nervous origin. Vaquez and Donzelet review the tests for the heart to be used in military service, and conclude that the only way to estimate the reserve force of the heart and its functional value is to make a thorough clinical examination of each case, completed by radioscopy and sphygmomanometry.

Tedeschi holds that in the discussion on "soldier's heart" too little attention has been paid to the influence of digestive disturbances on the cardiovascular system. He has observed in the Italian Army cases sent back from the front as suffering from heart disease (palpitation, pain in precordium, arrhythmia, weak pulse, etc.) in which the symptoms occurred only during digestion and were due wholly to distension of the stomach with gas, fermentation, aerophagia, motor disturbance, etc. Nasal obstruction due to hypertrophic rhinitis was often associated with aerophagia, and with the removal of these conditions the supposed heart disease also disappeared. In all of these cases the nervous or psychical element played a part.

Syphilis is ignored by practically all of the writers on "soldier's heart". The writer (Warthin) believes that both congenital and acquired syphilis play a very large part in the production of myocardial weakness in young men. Observations upon students developing myocardial insufficiency under the strain of athletic or field work have confirmed this view. A personal communication from Dr. Mortensen of Battle Creek, who has been engaged in cardiac examinations at Camp Custer states that a history of streptococcus infection (rheumatism, tonsillitis, etc.) is found in about 50 per cent of the cases of myocardial tachycardia, and that he believes syphilis to be responsible for the greater part of the remaining cases, although a definite history of syphilitic infection is usually not obtainable. On the other hand practically all cases of aortic valvular disease have given a history of syphilis. It is most probable that the streptococcus and the spirochete of syphilis are the two most important etiologic factors in cardiac infections; and examiners of drafted men and soldiers should bear this possibility in mind when examining. The gonococcus, pneumococcus, etc., probably play minor roles, although we have no data of value as to their relative importance.

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“TRENCH” NEPHRITIS.

A CRITICAL SUMMARY.

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I. INTRODUCTION.

A nameless “special correspondent” in Northern France for the British Medical Journal¹, in 1915, described as a “new disease” the nephritis with a general dropsy which at that time became prevalent among the armed forces of the Island Empire. In most cases the disease had set in rather suddenly with an antecedent history of sore throat or bronchial catarrh. A considerable proportion of the patients had but recently returned from the trenches, though the value of the factor of exposure was somewhat minimized by the observation that the worst part of the outbreak coincided with the coming of spring and not with the days when trench life was at its worst. After a few days of albuminuria, this usually disappeared entirely. No deaths were observed. A high proportion of the cases showed streptococcal infection of the tonsils though the “special correspondent” laid little stress upon this fact in attempting to explain the epidemic.

It was not long before Robert Saundby² correctly deleted the word “new” from this disease by asking whether a streptococcal nephritis in war-time was different from this same disease in peace, for had the “special correspondent” described anything but an epidemic of acute streptococcus nephritis?

Nephritis in the armed forces was, however, so common that for this reason alone a study of its nature and cause was urgently demanded—a demand soon satisfied through private and

government initiative by a blaze of papers which even yet shows no signs of abating. From the front and from home hospitals in the countries of all the belligerents, each day brings new studies, new letters and new opinions. Not very much has, however, been added to the original and first communications of Nathan Raw³, W. Langdon Brown^{4,5,6,7}, John Rose Bradford⁸, Rodolph G. Abercrombie^{9,10,11}, P. Ameuille^{12,13,14,15,16}, R. L. Mackenzie Wallis³⁰, A. Albu and E. Schlesinger¹⁷. Unless otherwise specified, it is upon the studies of these men¹⁸ that the paragraphs constituting the first portions of this paper depend. Papers^{47 to 60} and editorials⁶¹ by later writers, so far as these have been available, do little more than corroborate these earlier studies.

If the "new disease" had but a short life, the existence of "trench" nephritis proved equally brief when many of those affected were observed never to have been in the trenches. The whole subject may today be said to have simmered down to or broadened out to the mere discussion of nephritis as observed in men engaged in the various military services of the belligerents.

II. THE FACTS REGARDING WAR-TIME NEPHRITIS.

1. *Incidence of the Disease.*

The striking feature of this war-time nephritis and almost the only point upon which all the various students of the problem are agreed is its commonness. There seems never to have been a time except in our own Civil war when cases of nephritis in men of military age were so common. Against the peace incidence of less than one per cent, records from the front show several per cent of acute nephritis among the ill in military duty. M. Gaud and P. Mauriac¹⁹, for example, found 6.5 per cent with acute nephritis in two thousand sick and wounded who passed through their hands during three months of 1916, and this proportion was mounting steadily at the time at which they wrote.

2. *Etiology.*

Almost all the causes which in peace times have been listed as capable of producing nephritis are listed by different authors as responsible for this war-time nephritis. Hard work, exposure to cold and wet, high protein diet, alcoholism (in the case of the central empires), poisoning with metals, post-vaccination effects (vaccination against small-pox, typhoid and paratyphoid), previously existing kidney disease and infections of various kinds, all come up for discussion. W. Langdon Brown⁴ early emphasized the importance of infection. S. A. Bull²⁰ thought hyperchlorina-

tion of drinking water to be responsible for the nephritides observed in his battalion. Chas. Powell White²¹ examined five specimens from four cases of relatively chronic (lasting several weeks) trench nephritis and found lead in all the specimens. He points out the probable origin of such metals from tins containing food consumed by the expeditionary forces, appending some interesting observations on the solubility of tin and lead under different circumstances. C. Kayser²² holds war nephritis to be scarlatiniform in nature and possibly transmitted by lice. Singer⁴⁵ considers dysentery a predisposing factor. J. C. McWalter⁴⁶ thinks trench nephritis a renal manifestation of paratyphoid. John Rose Bradford⁸, while inclining to the theory of a mild infection as the chief factor in causing war-time nephritis, points out that the abnormalities of diet incident to the stress of active service must result in a loss of the normal salt balance in the body and with the unusual exposure give rise to temporary acidosis and edema of the kidney. Hirschstein²³, C. E. Sundell, A. T. Nankivell²⁴, Albu and Schlesinger¹⁷ also emphasize the importance of dietary shortages, the latter thinking an absence of vitamins perhaps responsible for the nephritis.

No one author will accept any or all these as the true cause of the nephritides which he describes. The debate which ensues is endless, for one author disposes of any given cause as unimportant in his series, only to have it resurrected as of fundamental importance in the series of a subsequent writer. We shall discover later that the reason for this wide variance in opinion is undoubtedly due to the fact that the different authors describe what are unquestionably entirely different forms of nephritis so far as etiology is concerned and that, as a matter of truth, a specified cause, ranked as of no importance in one author's series, may be the dominant one in that of another investigator.

3. *Signs and Symptoms.*

For the commonest and the predominant type of war-time nephritis the following features hold.

The attack comes on rather suddenly, a few days sufficing at the outside to bring the afflicted soldier to the surgeon. There is commonly a history of exposure to cold and more commonly still, one of continued drenching (Raw³). The patient may state that he has had a "chill". Often a swelling of the face, the legs and the scrotum, or an edema of the trunk constitutes the first signs of trouble. To these the examining physician may be able to add presence of fluid in the peritoneal or pleural cavities or in

the lung itself. Well marked edema somewhere is so common that Brown noted it, for example, in 53 of his 58 cases. The exceptions gave a history of previous nephritis.

It is generally said that a slight and irregular temperature is almost the rule in these patients, though this statement like every other that may be made in the course of this paper finds flat contradiction in the writings of other recognized clinical workers in these fields.

Some increase in blood pressure is commonly noted. Albu and Schlesinger¹⁷, however, noted none, in fact observed an actual decrease (100 mm. systolic) in their series. The best study of the blood pressure in these cases of acute nephritis has been made by Abercrombie¹⁰, who invariably found the systolic blood pressure to be raised (up to 200 mm.) during some stage of the disease though not ordinarily to such high points as are characteristic of what he terms "chronic" nephritis. The diurnal variations in the pressure were rather large and a pressure over the normal of 125 mm. was rarely maintained more than a few days. Usually there was a staircase descent in the pressure from day to day as the patient's general medical condition improved.

Brown, Abercrombie and many other authors describe dyspnea as a common and almost constant symptom in the majority group of the war-time nephritides. Brown noted it in 49 of his 58 cases. This author also points out that the shortness of breath and the presence of edema were largely coincident though the shortness of breath usually went away before the edema. Some of his dyspneics showed a reduction in alveolar carbon dioxid tension; though interestingly enough, Brown will not accept this close association between dyspnea, low carbon dioxid tension, development of edema, etc., as at all expressive of a generalized acid intoxication.

"Uremic" complications are relatively uncommon. Headache with nausea and vomiting are noted in many of the cases. Convulsive seizures occur sometimes; E. Magnus-Alsleben²⁵ observed five patients with such in his series. Four of Brown's 58 cases showed seizures and one of Raw's³ five.

Eye findings are also relatively rare. Friedel Pick²⁶, Albu and Schlesinger¹⁷ observed none. R. Foster Moore²⁷ noted 5 with signs of "renal retinitis" in 119 victims of "epidemic nephritis". Of the remaining 114, 7 showed small retinal hemorrhages; the remaining 107, normal eye grounds. This author attaches no significance to these small hemorrhages for he observed them in other patients who had coughed or vomited. In

the 5 patients showing "renal retinitis" he found the blood pressure persistently high. As we shall see later these were probably ordinary cardiovascular cases which simply got mixed up with the "epidemic nephritides" or had both types of disease at once.

The urinary findings are described as variable. Most of the authors agree that in the severer cases, there is a diminished output of water by the kidney reaching at times the extreme of complete suppression. Such urine as is voided is usually highly concentrated and contains considerable quantities of albumin. From traces, this may attain the values of ten, twenty and even thirty grams of albumin to the liter. Various casts are also found. Not only are these epithelial, granular and hyaline, but blood and fatty casts are also noted. Most authors comment on the commonness of blood in the urine, either in the form of red blood corpuscles or as dissolved hemoglobin, it being maintained by some that this liability to hemorrhage is characteristic of this war-time nephritis. It is worthy of note that most authors comment on the large number of leukocytes found in the urine.

4. *Course of the disease.*

But few of the typical cases of trench nephritis die. None of Pick's series succumbed; one of Brown's 58 died; one, of Gaud and Mauriac's series of 130. Somewhat out of keeping with these low figures are the statistics of Davies and Weldon²⁸, who say that four per cent of the victims die.

For the most part the urinary findings in the patients improve rapidly, the edema passes, the headache or other "uremic" symptoms disappear, so that in the course of a week or two the patient is practically well. In some of the cases, however, the story is a more protracted one. Certain authors find a persistence of the albuminuria for six, twelve and twenty weeks and sometimes the albuminuria was still present months after they first reported to the surgeon.

5. *Pathology.*

So few of the victims of this so-called trench nephritis die that not many kidneys have been seen post mortem. Those that are described run the whole gamut of the morphological pathologies. Large white and large red kidneys predominate. At times the kidneys are shrunken, with what remains of the parenchyma appearing red or gray. Glomerular nephritis, tubular nephritis and mixed forms, both acute and chronic in type, come in for description. Some of the writers comment on the spotty

type of the involvement as observed in the kidneys and nearly all (in the acuter types of nephritis) emphasize the large number of polymorphonuclear leukocytes found scattered diffusely through the kidney parenchyma or more definitely bunched in islands. Richard C. Clarke²⁹ found miliary abscesses in the kidneys from his case. Sundell and Nankivell²⁴ describe the nephritic changes as of patchy distribution. Pick²⁶ brings out the same point. Parts of the kidney, according to these authors, seem absolutely normal.

6. *Bacteriological studies.*

The infectious nature of the majority type of war-time nephritis is held to by many of the writers on the subject. It is not, however, accepted by all. Bacteriological studies of the subject are rather few and many of these leave much to be desired in quality. The importance of infection is emphasized by Saundby², Abercrombie¹⁰, F. G. Chandler^{31,32}, Davies and Weldon²⁸, Rostoski and Pantaenius³³, Pick²⁶, Gaud and Mauriac¹⁹, Richard C. Clarke²⁹ and E. Magnus-Alsleben²⁵. Many different pathogenic organisms have been isolated from the blood, the urine and occasionally, in case of death, from the kidney itself in these patients. Rostoski and Pantaenius³³ cultivated typhoid bacilli, Gaud and Mauriac¹⁹ bacilli of the typhoid and paratyphoid group from the blood and urine of their patients. Clarke²⁹ isolated a streptococcus and Citron¹⁸ also considers war nephritis a streptococcus infection. Beitzke and Seitz³⁴ describe Gram negative rods and spirochetes in the urine of some of their patients but in the majority they found no micro-organisms whatsoever. They therefore decide against the infectious nature of war-time nephritis. Friel and Drummond³⁵, describe distinctive circular bodies (yeasts?) as present in the urines of twenty-five cases of trench nephritis, while Robert L. Thornley³⁶, in one of the best papers on this subject, describes a hemolytic diplococcus isolated from the blood in every one of twenty-seven cases of trench nephritis.

7. *Treatment.*

Some of the writers on war-time nephritis say nothing at all regarding treatment, emphasizing merely that these war-time nephritides "tend to get well by themselves". Usually the patients are put at bed-rest and ordered upon a liquid diet or exclusive milk diet. The French and Germans run to salt restriction. Albu and Schlesinger¹⁷, for example, consider such the best form of treatment, though strangely enough they find that their severest cases and those developing "uremia" fare best if sodium chlorid

solution is dripped into the rectum. It is difficult to harmonize the advantages of salt restriction by mouth with those of salt administration by rectum. These authors also find the saline diuretics to produce best effects and they use such in preference to caffeine, theocin and other diuretics of this type. E. Magnus-Alsleben²⁵, without restricting the caloric intake, cuts down on salt and nitrogen and graduates the amount of fluid swallowed. Such treatment he found to be followed by copious diuresis. In some of his patients he tried Volhard's method of absolute abstinence from water and food for three days followed by copious drinking but he failed to note thereafter the free urinary output which Volhard had described. Gaud and Mauriac¹⁹ use no drugs excepting theobromin, depending chiefly upon rest and a milk diet. In "uremic" cases they resort to venesection. One of their two "uremics" died. Abercrombie^{9,11} with several "uremics" in his series of 95 patients lost none. He depended upon hot packs and magnesium sulphate.

Alkalies and hypertonic sodium chlorid solutions have been found by J. Mitchell Clarke³⁷ to be "most efficient in producing free diuresis in about 48 to 72 hours, with disappearance of edema and relief of accompanying symptoms such as dyspnea, headache, etc." Similarly happy results are reported by Herbert Brown³⁸.

Decapsulation of the kidney has been resorted to by S. Wilk³⁹ in four soldiers with severe nephritis and extreme general edema. The good results following the procedure are attributed by Wilk to the operation, though in our minds equal emphasis might have been laid upon the continuous administration of calcium salts which this author gave to control hemorrhage but which happen to be among the best dehydrating agencies for body colloids that we know today.

8. *Prognosis.*

The prognosis for war time nephritis is generally held to be good, both as to completeness of recovery after an attack and the question of death. Albu and Schlesinger¹⁷ insist that their cases run a subchronic or chronic course showing exacerbations after exposure to cold, dietary disturbances and hard muscular work. Davies and Weldon²⁸ also insist that the outlook for these patients may not be as favorable as has been generally accepted, while several of the German writers believe that their war-time nephritics should be invalided home permanently after their attacks.

III. COMMENTS.

Albu and Schlesinger, after maintaining that the experiences of this war have thus far added little to medical knowledge, find an only exception in the case of the kidney diseases. Yet even in this direction it would seem that such a conclusion is hardly justified. The whole literature on war nephritis is a jumble of facts and opinions to which most of the various authors have thus far, because of military pressure, either been unable to apply well recognized physiological and pathological teachings or else they are unfamiliar with what these are. We shall try to point out where a consideration of some of them might have proved of service in the general discussion⁴⁰.

1. *Regarding incidence of the disease.*

In peace times we are apt to wonder over the alleged increase in cancer, pneumonia, or diseases of the circulatory system, forgetting that those who have been cured or protected from the diseases more or less under control must live only to die later of unpreventable disease. So also in the case of this war-time nephritis those protected from typhus, cholera, typhoid, etc., may become victims of other types of diseases and, generally speaking, of those diseases of which we at the time know least. Therefore surprise at the apparent growing importance of nephritis seems hardly justified.

2. *Regarding the nature of war-time nephritis.*

Taking the various facts together, it is obvious, from what has been said above, that the majority of the cases are clear cut illustrations of infectious nephritis. This view has been accepted by many of the writers. The remarkable thing is that not all have like Abercrombie⁴¹ accepted this etiological moment for those of their nephritics who show temperature, increased pulse rate, obvious foci of infection (tonsillitis, pharyngitis, bronchitis, pyorrhea, infected wounds), decrease in urinary output, many casts with much albumin and the presence of large numbers of leukocytes in the urine. Even an absence or variation in some or all of these signs does not change the basic diagnosis. It is only necessary to carry in mind the fundamental studies of Frank Billings⁴¹, E. C. Rosenow⁴², E. R. LeCount⁴³, Leila Jackson, D. J. Davis and George Dick on the association between neglected points of infection somewhere in the superficial parts of the body and the more serious ones affecting distant organs like

the kidney, to see what has happened to large groups of men whom the exigencies of war have thrown together in crowds and often under conditions of hygiene which, to say the least, are distressing. Well may an insignificant epidemic of "colds", or tonsillitis or bronchitis mark the beginning of many cases of nephritis, so many in fact as to justify the appendage of the English observers who incline to the appellation "epidemic nephritis".

But even for the more isolated types of infectious nephritis must this association between distant entrance points and metastatic invasion of the kidney through the blood stream be kept in mind. Once such a diagnosis of nephritis is made, it becomes a matter of necessity and of duty to discover an entrance point and then it is all wrong to wave aside as of no etiologic importance the existence of infected tonsils, pyorrhea, infected wounds, gonorrhea with secondary infections, infected hemorrhoids, pharyngitis, bronchitis, etc. These are the things *par excellence* which in the isolated case or in the epidemics are the "cause" of this war-time nephritis.

War-time nephritis is strange neither in its signs nor its symptoms; we have simply had occasion to see in mass what may be observed in more isolated form any day in the nephritics of our general or hospital practice in peace times.

3. *Regarding correlation of urinary findings with type of kidney involvement.*

It is obvious that in these infected kidneys the points of infection may involve only small pieces of the kidney or may be so large in number as to involve practically the whole organ. This is verified in those better post mortem protocols which are already available and which describe kidneys, from those scarcely affected or affected only in trifling spots, to such as show the whole organ to be the subject of an acute or sub-acute diffuse nephritis.

Clinically such partial or complete involvement of the kidney brings with it, on the one hand, no change whatsoever in the amount of urine put out with but little albumin, few casts and few leukocytes, to the extreme, on the other hand, of complete suppression, with such urine as may have been voided previously heavily charged with albumin and full of casts, leukocytes and blood. What must be remembered is that three-quarters to seven-eighths and probably even more of the total kidney substance of an animal may be rendered functionless by disease or by direct

removal of this much kidney without the water output by the kidney being in any way affected. In other words, if one-eighth of the parenchyma of the kidney maintains its normal function, there may be no decrease in urinary output whatsoever. Such a normal water output is an index to the amount of kidney substance still functioning. An index to the amount which is impaired in function or actually destroyed is found in the amount of albumin and casts that are contained in such urine as may be secreted.

4. *Regarding edema, uremia, high blood pressure, etc., as alleged consequences of kidney disease.*

What has been said here of the chemical and morphological findings in the urine may also be said of the other signs and symptoms described in these war-time nephritics. Since complete removal of both kidneys from an animal is followed by no change in blood pressure, it is idle to continue to cite changes in blood pressure as an evidence of kidney disease. A patient with nephritis may show a normal blood pressure or an increased one but neither of these states has anything to do with the kidney. In the infectious types of nephritis which hold the middle of the stage in the war-time series the same etiological element, namely infection, which gives the soldier his nephritis, gives him also an increased blood pressure of a temporary type. The increased blood pressure observed in these soldiers is, in other words, the familiar one incident to most of the acute infections and the mechanism of the production of which is not yet fully understood. If the soldier is observed while his infection is still active or during an exacerbation, in other words at a time when he has increased temperature, an increased pulse rate and similar signs, his blood pressure is usually up. Later, because of the persistence of positive urinary findings, he may be diagnosed as a nephritic but because his infection has cooled down he is likely to show no increase in blood pressure whatsoever.

What has been said of the changes in blood pressure holds also for the edema likely to be observed in the face, body or legs of these individuals and also for their so-called "uremic" symptoms. Since double nephrectomy in animals or the removal of an only kidney in a human being is not followed by an edema, it would seem purposeless to continue harping upon a "nephritic edema" as a something which, it is inferred, is secondary to the pathological interference with the function of the kidney. In these war-time nephritics the edema observed in the body gen-

erally is not to be considered as consequent upon the kidney disease but as a manifestation in other organs of that same type of change (as edema) which in the kidney is called nephritis; and the edema in these other organs has behind it that same cause which gave edema to the kidney. In other words, the same infectious organisms or their toxic products which in the kidney produced swelling with the appearance of albumin and casts in the urine, produced swelling also in the other organs in the body and so gave rise to edema of the face, of the legs or of other body structures.

The same reasoning applies to the so-called uremia. Removal of all the kidney structures from an animal or from a human being does not result in nausea, vomiting, headache, coma, convulsions and death or any of the other signs usually designated as evidence of a "uremia" in the clinic. All these signs and symptoms are evidences of an edema of the brain and such an edema of the brain has behind it the same etiological moments as the edema of the kidney previously discussed which we call nephritis, or the edema of other structures of the body which are falsely regarded as consequences of the kidney disease. Simple as is this reasoning, only John Rose Bradford⁸ seems to accept it when he points out that the abnormalities in diet with exposure, the stress of campaigning and mild infections must result in a loss of the normal salt balance and a temporary acidosis. This in his opinion then results in acute edema with signs of suppression when this involves the kidney, in apathy, drowsiness and epileptiform seizures if it involves the brain, etc.

5. *Regarding "acidosis" in edema and nephritis.*

While active hostilities have rendered unavailable all communications on trench nephritis in their original places of publication, only isolated writers like Bradford and Clarke have made any conscious use, so far as we know, of the colloid-chemical teachings of the past decade regarding the nature and the cause of edema and nephritis. According to these colloid-chemical teachings, any cell or tissue holds what is designated as its normal amount of water only because of the hydrophilic colloids which it contains and because these exist there under conditions which give them a normal hydration capacity. Edema is the state in which this hydration capacity of the involved cells or tissues is increased beyond the normal. In large measure, the change characteristic of nephritis is that of an edema involving some or all of the cells of this organ. The causes of edema and of

nephritis are therefore largely the same and under this heading may be listed any substance or condition which will raise the hydration capacity of the involved tissues above their normal level. We now know that an abnormal production or accumulation of acids in the involved tissues is one of the most active of agencies in bringing about such increased hydration. Alkalies act similarly, though in the case of the human body they are of little importance because intoxication with alkali is hardly ever met except in poisonings. Amins are also capable of increasing the hydration capacity of the tissue colloids and since the toxic products of many infectious diseases are of this class, they assume much pathological importance. Other hydrating agents are seen in pyridin and urea, the former being relatively unimportant because not encountered except in poisoning, and the latter because in the concentrations reached even in pathologic states in the human body not leading to much increase in water absorption by tissue colloids.

In spite of the fact that many writers on war-time nephritis emphasize, along with the obvious signs of edema, the existence of dyspnea, of highly acid urine, of low alveolar carbon dioxide tension, of increased hydrogen ion content of the blood and similar things, too many of them raise the question of whether nephritis "is an acidosis or not" only to answer in the negative. And yet how else can these positive findings be understood except as evidences of an abnormally high acid content of the body cells? Independently of our own views regarding increased colloid swelling as evidencing itself in edema in some or all of the organs of the body (nephritis, uremia, anasarca, etc.), and its almost constant association with the evidences of acid intoxication, it is only necessary to point out that the English school of physiologists (Haldane, Priestly, Douglas, Pembrey, Poulton, Boycott, Barcroft, Hopkins, Ryffel, Keith, Flack, etc.) in one of the brightest chapters of modern physiology have proved beyond a shadow of a doubt how not only the normal mechanism of inspiration and expiration, but the abnormal one which evidences itself in dyspnea, are controlled and maintained for the most part by changes in the concentration of carbonic and other acids circulating with the blood through the medulla. But no adequate use of the scientific findings of even these men has as yet been made in order to obtain a proper interpretation of the clinical manifestations which are characteristic of the majority group of these war-time nephritides.

6. *Regarding etiological elements in war-time nephritis other than infection.*

If it is granted that there is clear-cut evidence of the existence of an acid intoxication in most of those patients who are the victims of a war-time nephritis—and the clinical findings can be interpreted in no other fashion—we may at once make an end of the long debate as to the relative etiological importance in this type of nephritis of exposure to cold, hard work, drenching, diets deficient in quantity or quality and a hundred other elements which are at one time brought up by one observer as “causes” in his series only to have them set aside as of no importance in the series of another observer whose patients happened to come from surroundings in which a particular element was inactive.

A paper such as that of Ameuille and McLeod¹⁵ may be taken to illustrate what is meant under this heading. These authors examined allegedly healthy soldiers under different circumstances for the presence of albumin in the urine and other signs of nephritis. They noted albumin and casts in 1.66 per cent of the French troops twenty-four hours after their return from the trenches. Similar troops who had not been in the trenches showed less than one per cent affected with albuminuria. If it is remembered that hard muscular work or loss of heat by the warm blooded animal (such as is incident to the cold and wet of trenches, for example) leads to an acid intoxication—facts well known to physiologists since the nineties of the last century—it is easy to account for this difference. More striking still is the observation that of British troops examined at a divisional bath, 4.73 per cent showed albuminuria. If these divisional baths are like most of our own camp baths, in other words, simply cold baths, it is an easy matter to explain this rise in percentage on the simple basis of exposure to cold. The figure, as a matter of fact, is remarkably low, for a higher percentage of albuminurias may be discovered in any gymnasium to which cold shower baths or a cold plunge is attached. Urine voided by British troops actually in the trenches during cold weather showed 3.53 per cent with albuminuria. British troops living in billets showed 2.91 per cent, while troops at home showed 1.12 per cent.

Ameuille and McLeod correctly classify these “symptomless albuminurias” with the albuminurias of “fatigue”, finding an additional factor for their production in the diet of the British soldiers which is high in protein and low in vegetables. These conclusions have been assailed by other writers but criticism is pur-

poseless. As Th. Rumpel¹⁸ points out and as we have known since Leube's work, hard-working soldiers are likely to show an albuminuria and we know now that hard work means nothing else than an intoxication with lactic and other suboxidation acids. Similarly, exposure to cold and wet bring about such acid intoxication and so does an excessive protein ration (which on oxidation yields a 25 per cent excess of acid over base), poisoning with various metals and, we might add, intoxication with the products of various acute and chronic infections. Even when vegetables are plentiful, they may not be sufficient to yield that surplus of alkali which is necessary under such war-time conditions to keep the body neutral.

Taking these several facts together, it would seem to us that it is somewhat purposeless to lay too much stress upon any one circumstance or condition as the cause of a war-time nephritis. Anything which will make for an abnormal production or accumulation of acid in the cells of the kidney will be an etiological factor in the production of the nephritis in that case; wherefore hard work, drenching, exposure to cold, metallic poisoning or infection with micro-organisms anywhere in the body or in the kidney itself may singly or altogether be responsible for the observed signs and symptoms presented by any individual nephritic that we may have before us in times of war.

7. Regarding exposure and liability to infection.

Since an infectious nephritis seems to be the dominant type in the war-time nephritides, the question arises as to whether there may be any relationship between the exposure so largely incident to warfare and the development of this type of nephritis. From experiments carried out by William B. Wherry and Fischer⁴⁴, such would seem to be the case. An irregularity in response to inoculation with virulent pneumococci led to the observation that rabbits and guinea pigs which died most quickly were such as showed at the time of inoculation a urine acid to litmus or to methyl red instead of the ordinarily alkaline one which is normal for these animals. Animals taken from their hutches and divided into parallel series, one of which was then "acidosed" by starvation for twenty-four to forty-eight hours, by the feeding of an exclusive oat diet for two or three days, or by exposure to cold in outdoor hutches, succumbed almost invariably and sooner than did their brothers who were treated in identical fashion as to time and type of inoculation but were previously and subsequently kept in warm hutches, fed a generous

mixed diet or actually given alkali in sufficient quantities to keep their urines neutral.

8. *Regarding the other than infectious types of war-time nephritis.*

While it is probable that the different parts of the kidney have different functions, it is a fact that no experiments free from criticism are as yet known to the physiologist which will permit him to distinguish between the functions of a glomerulus, a convoluted tubule, a descending loop of Henle or any other anatomical entity observed in the kidney. It is for this reason that we have at various times pointed out that it is, to say the least, premature to try on a basis of clinical observation alone to distinguish between glomerular, tubular and other types of nephritis. There is, in other words, only one type of nephritis and that we may call parenchymatous; but this parenchymatous nephritis, as already indicated above, may involve pieces only or all of the kidney, giving rise anatomically to what we have called a spotty parenchymatous or generalized parenchymatous nephritis. We have also pointed out above how either of these types may result from infection and how, depending upon the extent of such infection, there may result clinical pictures which vary from the extreme on one side of few casts and little albumin, with no changes in urinary output, to the extreme on the other hand of many casts and much albumin with a low urinary output to complete suppression.

The war-time nephritides which, because of absence of temperature, absence of increased pulse rate and absence of other signs of infection, do not fall into the majority group of these nephritides (the infectious nephritides) may belong under either of the headings of the spotty type of parenchymatous nephritis or the more generalized type. To consider the second of these types first, it is only necessary to point out that these are for the most part the consequence of some disturbance which affects the whole of the kidney substance and, generally speaking, this is an intoxication with some soluble poison which circulates through and therefore affects the whole of the kidney. We will only emphasize that such kidneys may be consequent upon such general acid intoxications as are incident to hard work, circulatory or respiratory disease, exposure to cold and wet, carbohydrate starvation, high protein intake, etc., or to the poisonings incident to the armed service as the metallic poisonings following continuous consumption of canned foods or the handling of metallic articles used in warfare, the gaseous poisonings secondary to "gas" attacks

or the combustion of explosives, etc., etc. It is this generalized type of nephritis which may be suspected when an absence of the ordinary accompaniments of infection are missing in the patient's clinical story, when he shows no increase in blood pressure and when a careful study of his antecedent history leads to the discovery of factors of the type enumerated above which are known to be positive for the production of nephritis. And, let it be remembered, such nephritics are liable to show edema elsewhere in the body and of the allegedly "nephritic" type. But such edema as previously noted is not due to the kidney disease, but the kidney disease and the generalized edema arose simultaneously, as it were, and were induced by the same cause or causes.

A spotty type of parenchymatous nephritis is also the characteristic and first change in patients who may have gotten into the armed service without the fact being recognized that they are the victims of vascular disease (arteriosclerosis). As has been emphasized repeatedly, the ordinary individual with "chronic interstitial nephritis" who shows high blood pressure and cardiac hypertrophy is not primarily the victim of kidney disease. The primary diagnosis in these individuals is vascular disease and nature's effort to compensate for the changes in the blood vessels evidences itself in cardiac hypertrophy and increased blood pressure. As the blood vessel disease affects and incapacitates or destroys pieces of the kidney, albumin and casts appear in the urine, though since large portions of the kidney are left in a normal state, there is no change in the amount of water put out.

The other signs and symptoms alleged to be the consequences of the kidney disease in such individuals are also to be interpreted not as consequences of the kidney disease but of the vascular disease as this affects other organs in the body. The "uremia", for example, is an edema of the brain secondary to the vascular disease; the "albuminuric retinitis", a series of changes in the retina consequent upon vascular disease affecting the fundus, etc.

Undoubtedly patients of this type have been included as aberrant forms in the general collection of the war-time nephritides. They must be separated from the majority type by the same methods of differential diagnosis which we use to discover the victims of vascular disease in peace times.

We should like to add to these remarks on vascular disease as a "cause" of nephritis the modifying statement that after this relationship is pointed out there remains to be explained the origin of the vascular disease itself. When this is done the

nephritis due to vascular disease also comes to be a subheading in the infectious nephritides for we hold that vascular disease is due to infection. Vascular disease is not, in other words, due to the circulation of some soluble poison through the blood channels. However bad alcohol, hard work, gastrointestinal poisons, etc., may be for an established vascular disease, this is not synonymous with saying that such caused it. Whenever a general intoxication strikes an organ, that organ is affected fairly uniformly, and so we should expect that if such a general poison were responsible for vascular disease, all parts of the blood vessel (like all of the media or all of the intima) would be uniformly involved. But it is characteristic of even advanced vascular disease to appear in spots. There must therefore exist for it a spotty cause. It is characteristic of micro-organisms producing thrombotic changes in the smaller blood vessels to give rise to such spotty destructive lesions; and it is such thrombosis with infectious organisms that we hold to be responsible for the lesions characteristic of vascular disease. The micro-organisms are caught in the smaller blood vessels which when it happens in the kidney, for example, explains the first changes observable in this organ and characteristic of vascular disease as it affects the kidney (the primarily contracted kidney). When large blood vessels like the aorta are affected, the primary change is again in the small blood vessels, namely the vasa-vasorum. Syphilis no doubt stands first in the list of the micro-organisms of etiologic importance in thus producing vascular disease but, as we have repeatedly emphasized elsewhere, the post mortem findings on animals in such experiments as those of Hartzell and Henrici show that streptococci and staphylococci and no doubt many other organisms derived from infected teeth, tonsils, etc., may be added to this list. We emphasize these facts because syphilis is not an unheard of infection in the army and because bad tonsils, infected teeth, chronic genito-urinary infections, etc., must all be taken into consideration when an attempt is made not only to explain a persistently high blood pressure, a cardiac hypertrophy, kidney changes or other signs and symptoms which collectively in peace times lead to a diagnosis of vascular disease or so-called chronic interstitial nephritis, but to do something for the relief of such stricken individuals.

9. *Regarding treatment.*

If the teaching is accepted that edema and nephritis represent, in large measure, only states of increased hydration of the

body colloids and that this increased hydration is induced through an abnormal production or accumulation of acid and similarly acting substances in the involved tissues, it is clear that one of the first things that should be done in the matter of treatment (after as many as possible of the factors as may be active in producing or augmenting the abnormally high acid content of the tissues have been removed) is the institution of active alkali administration to the point of keeping the urine persistently alkaline to methyl red or neutral to litmus and to continue such treatment as long as may be necessary. It strikes one as somewhat surprising in consequence that such administration of alkali as a routine procedure in the war-time nephritides has received but little attention. Only Bradford comments on the acid nature of the intoxication in these nephritides and only J. Mitchell Clarke and Herbert Brown comment upon the good effects following the use of alkalies in the men under their care.

And yet the reports of the various writers on war-time nephritis might be used, one might almost say, as evidence for the truth of the colloid-chemical nature of the disturbances observed in these nephritics and the important rôle played by acids and similarly acting circumstances in producing the abnormal hydrations which give rise to the signs and symptoms characteristic of this clinical entity.

If it is true that the clinical picture of nephritis is essentially that of an edema of all or parts of the kidney—the cause for which is simultaneously likely to produce an edema of the brain (uremia) and of other structures in the body—then the relief of such must obviously be associated with a reduction in this swelling. The giving of alkalies in order to neutralize an excessive acid content is one of the ways of reducing the colloid swelling. But even without neutralization of the acids such colloid swelling may be reduced through the administration of all salts. While sodium chlorid is effective in this regard, the salts of bivalent or trivalent metals or bivalent or trivalent acids are still more powerful. We bring up these points because they show why the salt restrictionists in their desperate cases find the administration of sodium chlorid solution by rectum or intravenously a life-saving measure. The body colloids will quite as readily take up sodium chlorid and dehydrate themselves if this is offered them through the rectum or from the blood stream as from the stomach. But more conclusive still are the constantly reiterated assertions that the saline diuretics, more particularly magnesium sulphate, are best in treatment. These so-called saline cathartics

or saline diuretics are simply the best dehydrators of protein colloids that we have. It should be remembered, too, that calcium salts and iron salts as well as small doses of calomel produce powerful dehydrating effects and this explains why such therapeutic procedures are described as uniformly beneficent in their action.

Since the entire purpose in the relief, more particularly of the acute types of nephritis and edema, is a dehydration of the involved tissues, it will be seen also why hot packs and all the schemes of restricted water intake (unless the bad effects of water administration are properly offset by the simultaneous giving of enough alkali and hypertonic salt) are likely to yield good results. A patient restricted to 500 cc. of milk or total fluid a day, even with functionless kidneys, continues to lose through lungs and skin a liter or two of fluid in excess of what he is taking in. Such therapy must obviously lead to a dehydration of all the body tissues and so to a reduction in the edema of any involved organ as well as to a reduction in whatever signs and symptoms may have been springing from that organ. To sweat a nephritic is not so important because "poisonous substances are thus lost from the body" but because sweating augments the natural loss of water through the skin.

Most of the authors on war-time nephritis agree that caffeine, theocin and other diuretics of this type produce little effect. This was to be expected. The war-time nephritics are usually possessed of good hearts and good respiratory systems. Save for the local mechanical interferences through compression of capillaries consequent upon the edema, the mechanism is therefore intact which supplies all the organs of the body with plenty of oxygen and removes from them their oxidation products. Theocin, caffeine, digitalis, strophanthus, etc., act as diuretics because they increase cardiac and respiratory activity. They will in consequence do little good in patients already possessed of normal function in these particulars. They will act best where heart disease, pulmonary disease and things of like nature cut down the oxygen supply of the body organs below the level which we call normal.

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WAR OEDEMA.

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In Germany and Austria there has appeared a form of oedema ("Kriegsödem") that has attracted much attention in the German medical journals of 1917. The disease is apparently one entirely dependent upon war conditions. It has been especially prevalent in the war prison camps, but large numbers of cases have also occurred in the larger towns and cities. In Berlin the first cases were seen in January, 1917. Males over forty were almost exclusively affected. The disease is peculiar in the sudden development without premonitory symptoms of a marked oedema, especially of the lower limbs, but also of the scrotum

and face, and in some cases ascites and hydrothorax occurred. No cardiac symptoms were presented, and the urine contained no albumin. The pulse-rate was slowed, and the blood showed a moderate anemia (3-4 millions red cells) that was regarded as due to the hydraemia. Diarrhoea was a common symptom. The chemical examination of the oedema fluid showed a high ammonia figure as compared with that of the oedema fluid of renal disease, and hepatic cirrhosis. When the patients were put to bed marked diuresis began with rapid disappearance of the oedema. Remissions and recurrences were common. According to Schiff the disease appeared with great suddenness in Vienna. He states that the pulse-rate was usually reduced to 42 to 56. During the period of recovery the amount of urine passed daily averaged 3-4 litres. All of the writers agree in considering the disease to be a form of metabolic disturbance due to underfeeding. Schiff regards it as similar to beri-beri and other diseases due to lack of vitamins. Other writers think the large amount of fluid ingested in the form of soups, watery vegetables, etc., may be a factor. Maase and Zondek regard the diminished supply of fats as the essential etiologic factor, and suggest that toxic products of albuminoid metabolism may damage the endothelium of the blood-vessels and thus cause oedema. The high residual nitrogen and ammonia values in the blood, urine and oedema fluids favor this view. These authors, acting upon this hypothesis, were able to cure their cases by feeding 100 grams of fat daily for a week, without rest in bed or other therapeutic measures.

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AVIATION FROM A MEDICAL POINT OF VIEW.

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Aviation is too new a science, the conquest of the air too recent and perhaps too incomplete for us to expect a well developed Pathology of Aviation. Naturally, from a medical point of view, our attention is first turned to the physical and psychical qualifications of aviators and out of this study we are rapidly developing

the physical and psychical examination of aviation recruits necessary to make flying safer than in the past.

Adler states that an aviator should be small, compact and wiry, with a bright eye and perfect vision including color vision. The very small size is no longer necessary. He should react quickly and co-ordinate well. He should not use alcohol or tobacco. The physician should especially examine for valvular lesions of the heart, high pulse pressure and rate. He should examine the blood for anaemia. The previous health of the candidate should be inquired into, especially as to fatigue, dizziness, nervous exhaustion, fainting, fits, asthma, haemoptysis and insanity. His family history with respect to apoplexy, hemophilia, tuberculosis and cancer should be taken into consideration. Schurmeier states that especial attention should be paid to the vision, to the organs of equilibrium and to the nervous system, because the effects of flying are manifest especially on the nervous system and indirectly on the general health through the nervous system.

Carmus and Nepper emphasize the importance of tests of the promptness and quality of response to various nerve stimuli, stating that auditory, tactile and visual responses should be prompt and normal, not excessive and not at the mercy of the emotions.

Jones and Small describe methods of examining the ear, particularly as to the equilibrium function. These consist of the turning chair, nystagmus, the falling test, past pointing, douching the ear, etc.

Aerasthenia, a natural or acquired lack of co-ordination between the eye and the hand, should disqualify a man for aviation.

The *physiologic effect of altitude* has been investigated by many workers, among whom are Dreyer and Walker, Lacroix, Tissot, Ferry, Guillemand and Regnier. Some of these reports, cover the volume and concentration of the blood, the pulse pressure and rate, the respiration, the special senses, the psychic functions, etc. While there is not entire agreement among the reports on all these points, it is generally noted that in normal individuals with normal arteries, altitude has little effect on pulse tension and rate. At the moment of landing, arterial tension is somewhat increased, especially in athletic, well trained men, while weak, fatigued men show cardiac palpitation and great acceleration of pulse, the tachycardia indicating cardiac insufficiency. Dreyer and Walker showed that diminution of the volume of the blood was common at high altitudes and was due simply to concentration of the blood, although after long residence at high

altitudes, there was actual increase of blood cells and hemoglobin.

Respiration is usually quickened and deepened at high altitudes and often a periodic breathing resembling Cheyne-Stokes breathing is noted. This effect is due to changes in the gases of the alveolar air, the blood and the respiratory center.

Vision is accentuated until dizziness comes on and decreases it. The accentuation is due partly to mental concentration and partly to atmospheric conditions. The tactile sense is said to be diminished. The equilibrium function of the ears is usually not affected but the auditory function is always affected; buzzing in the ears and deafness, especially after rapid descents are always noted and some serious ear lesions are reported after rapid descent from high altitudes.

The effects of atmospheric changes on psychic powers were tested experimentally by Loewy and Placzek. The cabinet in which the experiments were carried on was filled with air of a pressure corresponding to that of the atmosphere at an altitude of 4,000 meters. They noted a lowering of the power of attention and of prompt and precise action and think that this psychic effect may be the cause of many accidents. Ovington, however, a practical and experienced aviator, does not agree with Loewy and Placzek but believes that the exhilaration of flying overcomes the depressing effect noted in the experimental cabinet. Mental stimulation rather than depression was usual in his experience. Zuntz says that the clue to the successful pursuit of aviation is in the domain of psychology.

Some men, after flying at high altitudes constantly for some time without any ill effects, develop a marked susceptibility to the effects of high altitudes and experience most annoying palpitation of the heart and dyspnea even at relatively low altitudes. The cause of this condition seems to be a weakening of the myocardium due to a lack of oxygen.

Aviator's Disease or *Mal des Aviateurs* or Air Sickness is a well defined syndrome of symptoms which is frequently reported and seems to be a fairly common effect of flying to high altitudes; the lessened amount of oxygen may be the cause of this condition, since the sickness is much alleviated by inhaling oxygen. This disease has been described in detail by Cruchet and Moulinier, by Ferry, by Adler and others and has been discussed in various editorials. The symptoms during the ascent are dyspnea, tachycardia, slight malaise, *hyposcousie*, buzzing in the ears, headache, desire to urinate and almost intolerable cold. These symptoms are still more exaggerated during the descent. The worst effects

are headache, congestion and burning of the face and an invariable and irresistible desire to sleep. After landing, the noises in the ears, the headache and somnolence are still more exaggerated; vertigo, numbness and muscular weakness with cyanosis of the extremities continue for some time. The pulse is more rapid and the radial blood pressure is much higher than before the flight. Adler states that the substance of air sickness, as of balloon and of mountain sickness, is dyspnea, loss of appetite, nausea and vomiting, loss of muscular energy, accelerated pulse, venous congestion of the face, nasal and pulmonary hemorrhage, headache, torpor, numbness and an irresistible tendency to sleep which may lead to death.

During its relatively short history, most of the deaths and most of the serious results of aviation have been due to accidents. These accidents have been due in part to defective machinery, in part to imperfect mechanical knowledge and fitness of the aviator and in part, no doubt, to faintness and other physical derangements resulting from the high altitude, the rapid motion, the diminution of oxygen, the intense cold, etc. Also the hypnotic effect of the monotonous drum of the propeller may cause a mental lapse resulting in accidents. H. V. Wells has given a very good description of the physical causes of accidental deaths when flying. The horrible deaths or injuries resulting from high velocity falls are too well known to have any part in this paper. Generally the injuries are to the head or neck and may result from striking some part of the machinery and may be avoided at least in part by the safety belt. Certain results of interest are, however, noted in minor accidents. Frequently slight falls with only moderate shock may result in vague nervous symptoms persisting for months and incapacitating for work. The aviator may be machine shy always afterward and unable to fly. Sometimes there is profound shock without severe injury to account for it. Wells thinks there may be in these cases minor internal hemorrhages while the editor of the *British Medical Journal* suggests that fat embolism due to concussion of the bones without fracture may be the cause of the shock.

There may be severe eye injuries due to loosened bolts or screws flying into the face. Hartridge reports a case of rupture of the optic nerve as a result of the fall of an aeroplane.

Frost bite is a common injury due to the intense cold at high altitudes. Also there may be partial anaesthetization, headache and sleepiness from vapors or exhaust gases.

Aside from these injuries and their effects, myocardial weakening and respiratory difficulties are the main permanent pathologic conditions mentioned in the literature as the result of aviation.

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TRENCH FOOT.

A Review of the Literature of the Etiology and the Pathology.*

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DEFINITION.

Trench foot is the new name of the well-known condition of chilblains and frozen feet. Essentially it consists of various degrees of stasis of blood in the feet due to several causes, of which cold is the predominating factor.

HISTORY.

In civil life, chilblains and frost-bite are common in all cold countries, particularly among new arrivals who are not acclimated and who have not yet learned how to take care of themselves. In military service every army fighting in unfamiliar cold and wet climates since war began has suffered from the condition. In modern times the first good general description of frosted feet is that by Baron Larrey, Napoleon's chief surgeon, in 1812. His observations were extensive and his deductions as to the cause, the essential pathology and the principles of treatment have been but little improved on in a hundred years. In the Crimean war frost-bite was very prevalent among the English troops,—more than 2,000 men being invalided therefor—while the French suffered in still larger numbers as well as more severely. Though our Civil War was fought in a relatively warm climate by soldiers who wore loose trousers without leggings and many of whom as civilians had been accustomed to take proper care of themselves in severe outdoor conditions, yet the *Medical and Surgical History of the War of the Rebellion* contains records of many amputations of the toes and feet for gangrene following frost-bite. The Balkan wars were largely wars of movement rather than position, yet hundreds of cases of frost-bite were reported in the

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Turkish, Bulgarian, Greek and Servian armies. The present war, except for the first few months and especially on the French and Belgian fronts, has been a war of position to a greater extent than any previous conflict. It has been fought largely in water-soaked trenches, almost or quite freezing cold in winter, by men with bandaged legs and with little freedom of movement. As a result it has yielded a perfectly appalling number of temporary and permanent disabilities from trench foot. During the winter of 1914-1915 a number of British observers each reported from 100 to nearly 5,000 different cases. Of 160 patients admitted to the British Red Cross Hospital at Bologne, France, in one evening, 120 cases were of frost-bite alone, and many of them were stretcher cases. Preventive measures during the last two winters have reduced the number considerably, and yet hundreds of cases probably will be reported this winter. The prospects are that the highest percentage will be among our own men—the newest comers in France—unless vigorous preventive measures are taken at once.

PREDISPOSING FACTORS.

The predisposing factors of long standing are conditions of enfeebled circulation and lack of acclimatization to cold. Under-feeding, especially a lack of hydrocarbons and carbohydrates, diarrhoeas, loss of sleep, and the excessive use of tobacco as noted by Fearnside are all important predisposing factors in so far as they affect the amount or quality of the circulating blood. Lack of acclimatization to cold has been noted as an important predisposing factor by a number of observers. One medical officer with a large experience reports that approximately half his cases came from five regiments recently returned from India, Egypt and Malta, a percentage more than five times that from other regiments under similar conditions. The possibility of inuring the surface of the body to cold was well illustrated among the North American Indians prior to civilization. Many Chippewa children played naked in the snow, and their elders hunted in winter with little or no clothing, in northern Minnesota within the memory of men still living. The bare legs of Highlanders and the exposed throats and chests of women are similar illustrations. Any portion of the skin of the body may be gradually made as resistant to cold as is the face, the only conditions being that too large a surface shall not be exposed for too long a time, that the supply of heat-producing food shall be large, and that vigorous muscular activity shall be maintained.

IMMEDIATE CAUSES.

The immediate causes of trench foot are all those factors which tend directly to produce blood-stasis in the feet. The chief of these is cold. Lake has shown that the reduction of the soft tissues of the human body to a temperature of -6°C . (equals $+21^{\circ}\text{F}$.) or lower, produces true freezing and direct damage to the tissues by cell destruction. Degrees of cold above this critical temperature only produce their ill effects by vasomotor paralysis. Most of the cases of trench foot in the present war have occurred at temperatures above freezing and this has accounted in a large measure for the early confusion in identifying the condition as parallel in all its pathology with true frost-bite. Wet clothes rapidly extract heat from the body. During the first winter of the war many soldiers stood for hours or even for several days in cold mud and water, commonly up to their ankles and not infrequently up to their knees and hips, with no protection other than that of their ordinary uniforms. Under such circumstances, the abstraction of heat from the extremities is extremely rapid and the consequent vasomotor disturbances very great.

Walter and Rideal lay emphasis on the prolonged action of water on the skin. They state that "workers in paper manufactories who stand in several inches of warm water and paper pulp for a day at a time have symptoms similar to those of fishermen and otter hunters who stand for several hours in cold water." Since they found experimentally that salt water has less effect on the skin than fresh water and that recovery is more rapid, they recommend the prophylactic use of an ointment of lard or tallow with 4 to 10 per cent of sea salt.

Besides cold and wet, probably the most important immediate factor in the causation of trench foot is the absence of muscular contractions. Osler has written a brief article entitled "Cold-bite + Muscle-Inertia = Trench Foot", in which he notes that "the disabling effects of cold bite are inevitable in feet attached to legs whose muscles have not play enough to maintain circulation hampered by cold and wet."

The mechanical pressure due to tight puttees, leggings and shoes is a large causative factor. That crime against common sense, the spiral puttee, shrinking as it does as much as one-sixth its length when wet, especially has had many victims. The effect of tight shoes is shown by necroses and gangrene over areas where they have brought pressure, though it must be noted that the same areas are apt to be most affected even when not subjected to external pressure.

Hughes says that the usual position the men assume in the trenches while sitting on the firestep with their legs hanging over and feet unsupported, thus bringing considerable pressure over the popliteal space and impeding the return of blood along the popliteal vein, may be an important immediate causative factor.

Finally, however, it is of utmost importance to recognize that the chief demonstrable lesions in the affected tissues and those which are responsible for the pain, swelling, discoloration, ulceration and gangrene of the feet are not due to primary injury from the cold but to the too sudden reestablishment of the circulation with its resultant paralytic dilatation of the vessels, intense exudation and circulatory stasis leading to malnutrition.

SYMPTOMS.

Lawson says the cases may be divided clinically into those in which there is something to see with little or nothing complained of, and those in which there is nothing to see but a varying amount complained of. In the first group are conditions varying from mere hyperemia of the skin to actual sloughing of the subcutaneous tissue. In the second group there are sensory phenomena: parathesia, hyperesthesia, hyperalgesia, analgesia and anesthesia. Externally, three degrees of severity may be recognized; first, a transitory erythema usually disappearing rapidly; second, the formation of blisters beneath which necrotic areas of skin often exist and in which ulcers sometimes develop; and third, gangrene.

The chief complications are those due to infection with pyogenic cocci, gas or tetanus bacilli. Raymond and Parisot believe that a large share of the more complicated symptoms are of microbic origin. They have isolated an organism, which they find chiefly in the purulent layer of the vesicles, which, injected into the skin of the rabbit and guinea pig, gives rise to lesions similar to those exhibited in man.

DIAGNOSIS.

Ordinarily the condition is readily diagnosed from the appearance of the affected limb, though as has been noted above there are cases in which little is to be seen. Soldiers so affected must be distinguished from malingerers whose "cold feet" are merely a mental state.

PATHOLOGIC ANATOMY.

The blood stasis due to cold begins as an anemia, followed by hyperemia, exudation, capillary hemorrhages, vesication, malnutrition and gangrene. Though the general pathology of frostbite has been clear for many years, the investigations of Smith, Ritchie and Dawson, of Lake and others have materially increased our knowledge of the histologic conditions present. The first named observers conducted a series of experiments on rabbits in which they showed that the exposure of the rabbit's feet to cold mud sets up conditions parallel to those in trench foot. They found further that:

"Two turns of adhesive plaster around the limb greatly increases the amount of edema, and that when the tissues had been damaged by exposure to cold, edema was rapidly set up, or, if already present, was greatly increased by placing the animal's feet in water at a temperature of 37 C. (98.6 F.) The histologic examination of the tissues of the feet showed that the chief effect was on the blood vessels. In these there were dilatation of the lumen, swelling of the endothelium of the intima and vacuolation in the muscle fibers of the media. There was also increase in the number of cells of the perivascular tissue. There was no evidence of thrombosis in the vessels. The lymphatic vessels in some cases were unaltered; in others, they were dilated; and in others they were filled with masses of cells and fibrin. In the tissue spaces, the chief changes noted were (a) swelling and separation of the fibrils of the collagen bundles; in some areas where the fibers were widely dissociated they were undergoing solution in the exudate; (b) amongst the bundles there was a copious deposit of fibrin in the form of granules or of a network of beaded filaments. Fibrin granules and threads were also seen inside some of the blood vessels and lymphatics; (c) in cases, especially where edema had been present for some time, there was an abundant diffuse infiltration of the tissue with leukocytes; (d) in cases where the foot was subjected to warm water, the congestion was followed by a diffuse infiltration with red corpuscles; in some cases this passed into actual hemorrhage—the damaged blood vessels giving way under the strain of the congestion caused by the warmth.

"Generally a few staphylococci were found in the tissues of the feet. These were probably derived from the skin. While they increased in number, they had not acted in any way as foci of inflammation. Their presence in the tissue was probably a sign of the devitalizing effect of the cold.

"The changes in the nerves consisted in the edematous swelling of the axis cylinders, and this seemed to be merely a part of the general edema of the foot or ankle.

"The changes noted in the voluntary muscles consisted of a modification in their staining reaction, loss of striation, and in cases of longer duration, infiltration with leukocytes and a slight deposit of fibrin between the fibers. In muscles which had been actually frozen, these changes were more advanced.

"The regional lymph glands were enlarged from dilatation of the sinuses and hypertrophy of the follicles. The sinuses contained fibrin deposited in the form of granules and threads, and in the network formed by these were lying red corpuscles, polymorphs and proliferated endothelial cells. There was no evidence of the presence of micrococci."

Their general conclusions are:

"It is clear from experimental investigations that the essential change consists in the damage to the blood vessels. There is probably an initial constriction of the vessels, but when this passes off it is because of their damaged condition that the swelling of the feet occurs while the circulation is being restored to normal. The damage is evidenced by the swelling of the endothelial cells in vessels of all kinds and by the vacuolation of the muscle fibers in the arterial walls. An excessive amount of fluid is consequently poured out into the tissues, and in some cases the vessels rupture and hemorrhage follows. Along with the injury to vessels there is also an interference with the vitality of the cells of the surrounding connective tissues. Evidence of this is found in the readiness with which the fibrin formation occurs in the exuded fluid as contrasted with its absence in the form of thrombi in the blood vessels. Further evidence of injury is the infiltration of the parts with leukocytes and other phagocytic cells whose function is the removal of the products of tissue destruction.

"If the results of our experiments on the application of moderate wet cold for long periods be compared with what we observed as the result of very low temperatures acting for a short time, it will be found that no difference except in degree exists between the effects produced in the two cases. When extreme cold does not immediately kill the tissues, the resultant changes are practically identical with those of the longer application of the milder irritant.

"The relatively greater effect of wet cold as compared with that of dry is no doubt due to the fact that water is a much better conductor of heat than air.

"All our clinical observations can, we think, be rationally interpreted in the light of our experimental results. The swelling and redness are essentially the effects of an injury to the vessel walls, which, when the circulation is restored, originates what is in essence an inflammatory reaction; the unusual resistance of the edema to pressure is evidence of the presence of a semi-solid fibrinous deposit; the slighter degrees of blackening of the skin arise from diffuse interstitial hemorrhage from the injured vessels, such as we have experimentally produced—its evanescence is corroborative of its not being an evidence of true gangrene; the supervention of superficial or deep ulceration is an indication of the presence of a cellular necrobiosis which, if severe in degree, may go on to cellular or even gross necrosis; the slowness of the recovery, even when actual necrosis is not present, points to the occurrence of a regeneration such as our observation of experimental lesions would lead us to anticipate; the limitation of the nervous symptoms to the region of actual inflammation has its explanation in the absence of definite nerve changes in the artificial lesions, and leads us to attribute these symptoms chiefly to the external and secondary effects of the exudation.

"The nature of the changes produced sufficiently explains the slowness of the recovery in man. For this to be complete, not only must there be subsidence of the swelling, but there must be a restoration of the vessel walls so that they can bear the strain of the changes in the circulation which take place in ordinary forms of activity, that is, walking. There must be also a clearing of exudates from the lymphatic paths, and both processes require time. Hence, it is only found that, even when the swelling has disappeared, pain, tenderness and disturbance of feeling still persist; the patient is unable to walk about freely, and any application of warmth to the feet tends to bring back the symptoms."

Lake from a recent series of experiments on the effect of cold upon tissues under various conditions concludes that:

"In the production of trench foot cold must be considered the essential factor, other factors being either secondary or subsidiary.

"The use of vaso-constrictors delays the swelling in cases of true frost-bite while in cases of chilling the exhaustion may be entirely prevented."

TREATMENT.

The first treatment applied to trench foot, if improper, may cause so much tissue damage and so much suffering that its consideration is extremely important. The main principle of treatment has been for years a matter of common knowledge. Our only wonder is at the fact that some army medical officers have disregarded the principle. It was happily stated by Gross as long ago as 1859. He says: "The great indication is to recall the affected parts gradually to their natural condition by restoring circulation and sensibility in the most gentle and cautious manner, not suddenly or by severe measures. All warm applications whether dry or moist are scrupulously refrained from; the patient must not approach the fire, immerse his limbs in warm water or even be in a warm room."

Though every school child in the cold Northwest knows that he should rub his frosted ears with snow rather than hold them to the fire, hundreds of men with trench foot were told by their medical officers as well as their line officers to warm their numbed feet at the fire or to wash them with warm water. In an article published as late as June, 1915, in the London Lancet, a surgeon writes:

"The feet should be well covered with voluminous dressings of cotton wool. The wool should be four or five layers deep, loosely and thoroughly envelop the whole of the foot and extend up the leg beyond the area of pain and tenderness." Numerous other authors advocated the use of various forms of hot baths, stimulating local applications, and manipulations and general medication (including the administration of thyroid extract!), all having for their object the rapid restoration of circulation in the affected limbs. In May, 1915, Sir Berkeley Moynihan in a brief note vigorously called attention to the importance of leaving off dressings. He said: "Parts affected should be smeared with some ointment, covered with a thin layer of gauze, the feet raised a few inches from the bed upon a hard pillow and the lower part of the legs and feet covered in bed only by a sheet. Pain is almost exactly proportionate to the degree of warmth of the foot. The relief of pain should be our chief consideration."

The treatment of complications, infections, gangrene, etc., should be along ordinary lines and needs no comment here except a warning to surgeons not to be too hasty in advising amputations. It is a common experience that many frozen feet in which gangrene has developed to an apparently hopeless degree may be

saved by giving nature a chance. The skin and subcutaneous tissues may slough off slowly and leave very good feet with or without subsequent skin grafting.

PROGNOSIS.

In cases of mild and moderate severity patients if properly treated initially get completely well of themselves but, even in mild cases with bad primary treatment they are left with permanent hypersensitiveness (chilblains) and a tendency to recur with subsequent slight chilling. The changes in the vessels of the legs may be so great that chronic ulcers persist for years following amputations of the feet for gangrene.

PREVENTION.

Preventive measures obviously are to be directed to keeping the extremities warm and the blood circulating in them. The British Army Routine Order No. 353 of November 23, 1914, gives the following precautions:

"1. Boots should not fit tightly; should at least be a size too large. When large boots are worn it is well to wear two pairs of socks but this is dangerous if the boots are small, as it leads to further pressure on the foot. Puttees should never be applied tightly.

"2. The general circulation can be kept up by keeping the body warm and dry. A mackintosh sheet worn over the great-coat is of assistance when no waterproof is available.

"3. A dry pair of socks should be carried in the pocket when available.

"4. The officer should see that dry standing is provided in the trenches whenever possible by means of drainage, raising of the foot level by fascines of brush, wood or straw, with boards on top, or by the use of pumps, when these are available."

Recently the more permanent trenches in many places have been floored with latticed foot walks, so-called duck-boards.

Leggings and puttees under conditions of cold and wet should be abandoned. There is no doubt that the soldiers in our Civil War escaped frosted feet to a very great degree because they wore loose fitting trousers and the circulation was unimpeded by tight clothing around their ankles. The Swiss soldiers, trained in a country with much snow and ice, wear no leggings or puttees but loosely overlap and button the cuffs of their trouser legs near the ankle. The Northern lumber-jack, working throughout the

winter in deep snow in extremely cold weather wears two or three pairs of woolen socks in loosely laced shoes but rolls up or cuts off the legs of his trousers well above the shoe tops. Tradition in lumbercamps has developed a system of foot protection, marvelously efficient. The lumber-jack takes more time to dress his feet in the morning than he does to dress the rest of his body. His shoes and socks are carefully dried every night. His boots with heavy rubber bottoms and well oiled 8-inch leather tops are excessively over-size. When his feet are numb he kicks and dances. If they are frosted he takes off his shoes and socks and walks in the snow. As a result of these precautions frosted feet are almost unknown in the Northern lumber camps.

Délépine, as the result of extensive experiments, recommended in 1915 the use of leg-bags of silk, water-proofed with oxidized linseed oil for protection. These are worn over the socks inside the boot and inside the trousers. Many thousands of these have been issued to the British troops. In Germany the Special Military Committee for Warm Underclothing, formed at the suggestion of the Empress, has sent to the soldiers thousands of yellow, oiled and waxed paper covers to go on the foot inside the boot. While I have seen no detailed report on the use of either the English oiled silk bags or the German waxed paper leg-bags, it is probable that they have proved only temporarily impervious to the water and that when once water does get into them and soaks the contained socks and underclothing they give practically no protection from the cold, being themselves fairly good conductors of heat.

Covering the feet and the legs with grease such as tallow, linseed oil, vaseline, etc., is a common preventive measure against wet and cold. Lumber-jacks when long exposed to ice cold water while river-driving logs, not infrequently paint their feet and legs with zinc oxide paint. Such preparations serve to a very limited extent only as non-conductors and act chiefly in preventing maceration of the skin with consequent constriction of the surface capillaries.

Both clinical experience and animal experiments have shown that prolonged exposure to moderate degrees of cold and wet is quite as bad as short exposure to extreme degrees. Therefore, the length of service of soldiers in the trenches, if possible, should be shortened when their feet are wet and cold. Soldiers in trenches must be encouraged to keep the muscles of their limbs moving as much as possible when their feet are cold and wet, thus greatly aiding circulation. Hughes, by insisting that the men of his

regiment should, when resting at night, lie with their feet on the firestep, cut down his cases of trench foot to a negligible quantity.

Heat-producing food must be provided in as large quantities and in as appetizing and digestible condition as possible.

Men should be warned of the danger of the over-indulgence in tobacco, since it paralyzes the nerve ends of the vasomotor nerves.

The whole matter may be summed up in the three directions: Keep the feet as warm and dry as possible and keep good blood circulating in them. If over-chilling does occur reestablish circulation slowly and not by warm applications.

An excellent article just published by "A Military Observer" reprints the leaflet issued by the British Army on "Chilled Feet and Frost-bite," as follows:

"Experience in the worst part of the line shows that where effective preventive measures are taken the so-called trench foot does not occur. The occurrence of even a single case in a battalion is therefore a reproach to the unit concerned. The following preventive measures will be adopted forthwith:

"1. *Foot Preparation Rooms.*—Each brigade will provide rooms in which the feet of men will be washed in tepid water and rubbed before proceeding for a tour of duty in the trenches. The A. D. M. S. will provide personnel for supervision of these rooms.

"2. *Drying Rooms.*—Each brigade will arrange for rooms in which clothing, socks and puttees can be thoroughly dried and dry socks provided on the return from trenches.

"3. *Provision of Dry Socks.*—A pair of dry socks for each man will be sent to the trenches with the rations daily. Wet socks will be sent back to transport lines by ration carrying parties. Socks will be sent up in waterproof boxes or bags.

"4. *Fitting of Socks.*—Socks must not fit tightly and should be inspected as carefully as boots.

"5. *Care of Ankle Boots.*—Company officers will see that the following precautions are taken regarding boots: (a) Sound laces will be provided to facilitate taking off of boots, as knotted laces delay or prevent removal. (b) Boots will be dubbened outside to keep out wet. (c) Boots will be fitted loosely. (d) Boots will be laced loosely. (e) Boots will be kept in good repair.

"6. *Care of Gum Boots.*—Brigades will make arrangements for the drying of gum boots. Officers commanding will be responsible that gum boots are properly stored when not in use.

They must not on any account be left on the ground outside dugouts.

"7. *Care of Puttees.*—Puttees must always be applied loosely and when they become wet must be taken off and reapplied as they shrink on becoming soaked with water.

"8. *Removal of Boots in the Front Line Trenches.*—Platoon commanders must arrange for each man to take off his boots at least once in twenty-four hours. A scheme will be worked out for men to do so in rotation even if it is necessary to sit on the parados at night.

"9. *Stamping Exercises.*—Circulation will be kept up by stamping when possible and keeping the men employed in various ways. Nothing is more conducive to trench foot than standing about.

"10. *Personnel for Supervision of Preventive Measures.*—Regimental stretcher-bearers will assist company commanders in the supervision of preventive measures, and two men per platoon will be trained by regimental medical officers in foot massage. On relief after a spell in the trenches these men will be sent ahead to rest and be prepared to start operations as their platoon arrives.

"A trained masseur of the R. A. M. C. will start a course of instruction of foot massage for regimental stretcher-bearers forthwith.

"11. *Hot Food and Drinks.*—The provision of hot food and drink is of first importance in the prevention of the conditions which predispose to trench foot.

"Officers commanding will arrange for their men to have at least two hot meals a day; for preference one in the middle of the day and one between midnight and 5 o'clock a. m. Food containers of the Thermos variety are available and should be used to the fullest extent. They can be readily supplemented by petrol tins placed inside a double chambered wooden box with a layer of sawdust between the two boxes. Two 2-gallon petrol tins used in this way will give 64 men half a pint of hot soup or cocoa each.

"12. *Transport Lines.*—Men working in the wet transport lines of the Ypres salient require consideration only next to that of men in the trenches.

"Transport officers will see that the precautions outlined above are carefully observed.

"13. *Anti-frostbite Grease and Whale Oil.*—All ranks must clearly understand that the grease or oil supplied is merely a

lubricant to facilitate rubbing of the feet. The grease has no inherent quality and merely smearing the feet is worse than useless. The feet must be rubbed until all grease or oil has disappeared and they are quite dry.

"14. *Feet Inspection*.—Platoon commanders must be made to realize that the condition of their men's feet is as important as the condition of their rifles and that feet inspections are just as essential in trench warfare as in marching tests. A good platoon commander should be as familiar with the condition of his men's feet as he is with the cleanliness of their rifles."

TRENCH SHIN.

Though most observers describe the condition commonly known as "Trench Shin" as part of the syndrome of "Trench Fever," Chambers has attempted to differentiate it therefrom. For the present, however, the discussion must be left to those personally familiar with the condition. (See article on "Trench Fever.")

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“BIG BELLY” IN SOLDIERS.

EDITOR'S NOTE.

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Under the term “*Les gros ventres de la guerre*” Denéchau and Mattrais describe a group of cases in which the chief symptom is “big belly” associated with variable accompanying disturbances, such as discomfort after meals, breathlessness on the march, hyperchlorhydria, diarrhoea of colitic type, aerophagy and sialophagy. The patient is usually a soldier sent back from the front, complaining of ill-defined functional symptoms, chiefly gastrointestinal. The symptoms may be so pronounced as to lead the medical officer astray, even to making a diagnosis of Pott’s disease. The prominence of the abdomen may be as marked as that of a woman seven or eight months pregnant. In most cases there is faulty position of the pelvis and dorsolumbar spine, with active contraction of the diaphragm. The abdominal musculature shows general relaxation, especially at the level of the oblique and transversalis muscles and even of the quadratus lumborum. Upon radiosopic examination during relaxation the curve of the diaphragm is found to be normal and the respiratory movements are of regular amplitude. Organic disease of the vertebrae can be ruled out also by radiosopic examination. The writers mentioned above think there is no question of simulation in these cases, but there is often exaggeration and autosuggestion resulting from some gastrointestinal condition which leaves behind some sense of abdominal discomfort. This directs the patient’s attention to his digestive tract, and he begins to suffer from sialo-aërophagy. From this it is but a step to the autosuggestion that he has a serious disease of the abdomen. Hence, when the patient presents himself to the medical officer he exaggerates the size of his belly, which is the chief seat of his symptoms, by thrusting the abdomen forward, drawing in his chest, holding back his elbows and pressing his hands to his sides as if carrying his belly. The diagnosis rests on the disproportion between the abdominal enlargement and the slowness of the coexisting general and functional disturbances.

It is possible that some of the cases of “big belly” in soldiers are similar to the big belly of motormen and other workers who are upon their feet for a long period of time without opportunity to evacuate the bladder at accustomed intervals. Gastropnoia and distention of the bladder are the chief features of

this occupational disorder. It is found most frequently in individuals presenting the stigmata of the asthenic constitution.

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THE OTOPATHIES OF WAR; WITH ESPECIAL REFERENCE TO THE TRAUMAS DUE TO AIR WAVES.

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Ear troubles in war may be grouped under three headings, each of which may be subdivided.

I. CONDITIONS NOT CAUSED BY WAR ENVIRONMENT.

In this group belong all the ear troubles existing at the time of recruiting; these include almost every pathologic condition of the external, middle and internal ears known in civil life. These are considered only from the standpoint of their bearing on the military serviceability of the recruit. The degree of deafness that disqualifies for military service or that determines the placing of the recruit in some auxiliary service rather than the combatant army varies with the different nations and will not be detailed here. Perfect hearing and perfect functioning of the vestibular apparatus of equilibrium are required for only one branch of the service, the aviation corps. A detailed account of the tests as standardized for the American aviation corps is given by Jones. Cerumen plugs, furunculosis, and other external ear lesions occur as in civil life; some have said that they are aggravated by army life. Chronic and acute infections of the middle ear and their various sequelae are the same as usual and only the suppurative type with a foul discharge disqualifies for active duty in most armies, and in them only until the discharge can be suppressed. An "awakening" of chronic into acute stages due to the living conditions in armies seems to occur very commonly and a majority of all the ear troubles that army physicians handle are middle ear infections and their sequelae. Schlittler, in an otological report of the Swiss army, makes a plea for more care

in childhood in preventing otitis media as a measure of importance to the State in later years. This is in line with the efforts of many others. There has been considerable discussion as to the predisposition to indirect trauma due to previous middle ear alterations; this will be considered under the heading of traumas due to detonations. Labyrinthine sequelae, both cochlear and vestibular, are the same as in civil life and will not be discussed here.

II. TRAUMAS DUE TO THE DIRECT ACTION OF PROJECTILES.

Many cases of this nature have been reported. These wounds may be of any part of the ear mechanism; the etiology, pathology, symptomology, treatment and prognosis depends in each case upon the individual circumstances; these belong most properly with surgery of the head. Include under this heading also the injuries to the middle ear and labyrinth due to the indirect fracture of the base of the skull through the temporal bone caused by projectiles or other objects striking on the vault of the skull or on the mandible. Studies of the temporal bones of such cases have been made by Scott and by J. S. and John Fraser. Such cases occur also in civil life; Hoffman reported the histologic findings of one which is similar to the war cases.

III. TRAUMAS DUE TO THE ACTION OF AIR WAVES.

These are commonly known as "indirect injuries without external wounds". I prefer the heading given above because the conditions resulting are as truly traumas as those caused by projectiles. These injuries may be divided into two groups on the basis of the nature of the air waves.

(a) *Injuries due to noise.* Modern battlefields gradually cause a "noise deafness", in which the lesions are doubtless similar to those occurring in cases of "boilermakers' deafness" and other so-called "professional" deafnesses of civil life, though no one has yet reported the microscopic study of such a case of "noise deafness" developed in this war. Ever since Habermann's report in 1890 of the histologic condition of the labyrinths of a case of noise deafness, the evidence, both from numerous human cases and from experimental work with animals, has accumulated until it is certain that the symptoms of hard hearing or even total deafness to certain notes are due to degeneration of regions of the organ of Corti and the associated parts of the cochlear nerve. The reports of Müller, Friedrich, Jachne and others before the present war began showed that a large proportion of artillerymen and

naval men developed a noise deafness, and as the use of high explosive shells in modern warfare has placed the infantry in an environment resembling that of artillerymen it is to be expected that they, too, will develop many cases. Jobson recently reported on 60 cases chosen at random from soldiers who had been away from the Front long enough to have recovered from any temporary effects upon the hearing; he found that 100 per cent showed a measurable degree of deafness. An editorial writer in the *Lancet* justly criticizes the technique of his tests; but, even allowing for errors, the report indicates that many of the men in the army have developed or will develop a greater or less degree of noise deafness. It is to be hoped that more reports like Jobson's will be made.

Because of the belief still held by some that bone conduction, rather than air conduction, is the injurious agent in producing noise deafness, a brief review of the history of this discussion is included here. The experiments of Wittmaack ('07) on guinea pigs furnish the chief support for the bone conduction theory. This worker at first employed a continuously sounding electric bell placed in the cage near the animals, and killed them at intervals of from 5 to 60 days. The results were negative. He then connected the bell in such a way that the clapper caused the sheet iron base of the cage to vibrate, in addition to producing air vibrations, and thus submitted the animals to a combined air and bone conduction. The cochleae of the animals of this series showed very marked injuries to the nervous elements and to the organ of Corti. The animals were so affected by the continuous vibration of the cage that the experiment was forced to end after 16 days. Then experiments were made in which the sound was maintained for from 10 to 14 hours daily, and in these series the general health of the animals remained good and they even gained in weight. Characteristic degenerative changes were found in the spiral ganglion cells, the nerve fibers, and the organ of Corti. Wittmaack concluded from these experiments that bone conduction is essential to the injury of the labyrinth by sound waves. In 1909 von Eicken reported experiments on guinea pigs with the incus removed on one side by operation, so that one side retained normal conduction and the other mainly bone conduction. Part of these animals were submitted to the action of the waves from a 'c' organ pipe, others to those from a 'g' pipe. The cochleae of the 'c' animals were negative on both sides; those of the 'g' animals showed degenerative changes on the normal side in a circumscribed area, while the operated side remained normal. In

1911 he reported more evidence of the same nature. Hoessli ('12) combined the use of guinea pigs with the incus removed on one side with the use of a specially constructed apparatus designed to duplicate as nearly as possible the working conditions of boilermakers. The animals stood on the inside of a section of large iron pipe which was struck by hammers operated by machinery. Thus both air and bone conduction factors were present. Hoessli found that injuries to the cochlea were constant where normal middle ear parts were present, and just as constantly the side with the middle ear chain broken remained normal. As controls, animals with both ears normal and with both incuses removed were employed. In 1913 the same workers reported further experiments in which similarly operated animals were placed on a felt pad in the iron pipe as a test of the prophylactic measures recommended by the Wittmaack group of workers. The results were the same as when the animals stood directly on the vibrating pipe; he thus advanced strong arguments against bone conduction being essential to injury. Friedländer ('15), on the basis of Hoessli's experiments and his own clinical experience, concludes that air conduction is the injurious factor. Bogdanoff-Berezovski¹ ('14) criticizes Hoessli for transferring the results of his continuous sound experiments on animals with the incus removed to detonations on the normal ear, and argues that bone conduction here may be very different than with less intense sounds, but he brings forward no proof for his opinions. Siebenmann ('15), in a review of the experimental work on sound injuries of the ear, concludes that the use of felt pads, padded shoes, and rubber gloves for protection on the basis of bone conduction, is of no avail. From the evidence it seems proper to conclude that the traumas are due to air waves.

(b) *Injuries due to nearby explosions.* "Detonation waves" is the term most commonly employed to describe the movements of the air near an explosion; I prefer to limit the use of the collective term "War Deafness", which has been very loosely and variously employed by writers, to the conditions caused by these waves. To understand the injuries it is necessary to know something of the nature of the injurious agent. The firing of a gun or the explosion of a shell or other confined explosive charge produces a sudden increase in the amount of gas in a small region; this of course tends to expand and so equalize the general pressure. The generation of the pressure occurs in a time interval so brief that the expanding gas resembles a greatly magnified condensation phase of a sound wave. A rarefaction phase of cor-

responding intensity follows the condensation. Thus a detonation wave is seen to differ markedly in nature from the more usual mass movements of gases, which are currents rather than waves. Upon the amount of explosive, or, more exactly, upon the amount of gas generated and the time required to completely convert the explosive into gaseous form, depends the initial compression of the condensation phase of the detonation wave; this determines the distance to which the wave travels before the amount of condensation is reduced, because of the spherical nature of the wave front, to a value that places it among the waves which are classed as sound waves. Only an arbitrary line can be drawn between these. Lord Rayleigh's experiments indicate a minimal value for the condensation of continued air waves that can be perceived as sound by the human ear of 6×10^{-9} ($6/1,000,000,000$) atmosphere. The compression of the gases released when a projectile leaves the muzzle of a gun or when a shell case bursts varies with many factors but is always measurable in terms of multiples of atmospheres. Evidence collected by Mott and others indicates that men in the range where the compression is increased by more than one atmosphere die almost instantaneously, whether because of the variations of the gas tensions in the body fluids or because of toxic gases generated by the explosive or because of some as yet unknown reason, cannot be said in many cases. Accordingly the pressures that affect the ear without causing fatal lesions of other parts are probably of a value ranging from twice normal downward. The air changes due to the passage of a projectile nearby ("vent d'obus" of the French authors) may be of a similar nature, but there is considerable dispute among clinicians as to whether any of their cases can really be traced to such an origin.² Delacour considers the question carefully. He concludes that even large shells passing close above troops do not cause ruptures of the tympanic membrane, but that cases apparently of this nature can be traced to an "awakening" of a chronic infection and he thinks that the passage of a shell is a coincidence merely.

The injuries to the hearing apparatus may be subdivided into three groups, following many clinical writers.

- (1) Injuries to the middle ear.
- (2) Injuries to the labyrinth.
- (3) Injuries to the central nervous system.

These may occur separately, or any two or even all three may occur simultaneously. The reports vary as to the exact ratios, naturally.

I. INJURIES TO THE MIDDLE EAR.

These range from temporary inflammation through areas of blood extravasation and edema up to various degrees of rupturing of the tympanic membrane, with associated partial or complete destruction of the ossicular mechanism. The causative agent is evidently the difference in air pressure on the two sides of the tympanic membrane. That the pressures present are sufficient to rupture even normal membranes is evident from the experiments of Zalewski. He secured 232 temporal bones at autopsy; of these, 112 had apparently normal tympanic membranes. With air pressure gradually raised he found the average bursting pressure to be 120.9 cm. of mercury, but some (10.8 per cent) burst at less than one atmosphere (76 cm. Hg). Twelve membranes with thin spots ruptured at an average pressure of 42.83 cm. Hg. and twelve with scars at 22.08 cm. Hg. In twenty cases of acute infection of the middle ear the average pressure required to burst the tympanic membranes was 78.55 cm. Hg. Making no allowance for the possible difference in pressure required to burst tympanic membranes when applied suddenly by detonations as compared to the gradual increase used in the experiments, it is evident that in an average group of men there are many whose tympanic membranes will be ruptured by the pressures produced in the neighborhood of large explosions. Wicart and Delacour, among others, have expressed the belief that normal tympanic membranes are never ruptured by detonations. The mass of clinical evidence and Zalewski's experiments indicate that many middle ear troubles render the tympanic membrane more susceptible to injury by detonations. Shuter and Delacour say that the shape of the external canal and its direction with reference to the source of the detonation wave influence the danger of rupturing. Texts state that the rupturing of the tympanic membrane results in less injury to the labyrinth than would otherwise occur; the theory being that when the membrane remains intact the full force of the blow is transmitted to the labyrinth, while a rupturing membrane fails to transmit so much of the force. Mayer says that he has not found this to be the case, and thinks that the enormous detonations, as compared to those usually causing injury in civil life, may account for this difference. Lermoyez and Got both express the belief that men with healthy middle ears are more likely to suffer labyrinth injury than those with defective middle ears. The majority of the ruptures have occurred in the inferior half of the membrane;

many stating that they have seen no cases involving the pars flaccida, but a few such have been reported. With modern technique the treatment required to secure a healed membrane with perfect restoration of function is readily given, and the prognosis is good if infection of the middle ear can be avoided. Unfortunately, because of the dirt and filth of combat life, and because of the mistaken zeal of poorly trained attendants who douche every ear for almost any complaint, infection frequently occurs with the danger of the customary sequelae.

Inflammation of the middle ear without infection or rupture of the membrane is very common, but is fortunately only temporary and disappears without treatment in a few days.

II. INJURIES TO THE LABYRINTH.

The thousands of cases of labyrinthine injury due to trauma by detonations have added very little to the knowledge of the pathologic histology of the inner ear in such conditions. The report of J. S. and John Fraser is the only one that has been made upon autopsy material from such cases, and the histologic technique employed by them was such as to render the results very indefinite, as they realized. Hemorrhage into the labyrinth and about the entrance of the nerve roots in the fundus of the internal meatus are definite findings of interest. It is greatly to be desired that studies be made upon the temporal bones from cases in which careful clinical histories have been obtained. Due to the exigencies of war it may be difficult to obtain suitable material from cases injured but a short time before death, but in later years as the men who were injured in this war die it certainly will be possible to make a thorough study of the permanent lesions produced. It will be interesting to compare these conditions with those that have already been produced in animals experimentally, for the clinical history of the labyrinth functioning that can be obtained from animals is very meagre and therefore the correlation of symptoms and lesions rather unsatisfactory. The organic injuries of the labyrinth by detonations are fairly well known since the work of Wittmaack and those who have modified his methods. While in their experiments with animals Wittmaack, Yoshii and Hoessli all used small firearms, the effects on the ear are doubtless similar to those that would be produced by large guns and by shells, for they compensated by using short distances. Recently Prenant and Castex ('16) placed animals in cages near cannons at Fountainebleau. That these animals were

subjected to conditions of the type that cause gradual changes rather than detonation effects is evident from the fact that in no case was the tympanic membrane ruptured or the mucous membrane of the middle ear inflamed. They found extensive cochlear lesions of the type to be expected from previous work in this line, though they make no reference to other work and apparently consider the experimental causation of such injuries a new thing.³ Yoshii ('09), at Basel, has made the most extensive study of the effects of detonations on the inner ear, using a revolver fired near the animals. He used two series of guinea pigs. With one series only one detonation was used, after which animals were killed at once and after 2, 3, 8, 25, 45, and 60 days. The other series were exposed to detonations daily and animals were killed after 3, 5, 15, 20, 25, and 30 days. It is the once exposed animals that are of most interest here; and for presenting the nature of the injuries to the inner ear caused by detonations rather extensive translations from Yoshii's report will be used. The injuries are probably similar in man.

"Pathologic changes occur simultaneously in all parts of the organ of Corti. The outer and inner hair cells are greatly swollen, they have lost their characteristic form and structure and are in part loosened from their support. The nuclei are pushed upwards and frequently are broken into small fragments. Also the Deiter's cells lose their structure and become changed into a homogeneous mass. Their supporting fibrils perish. The pillars remain but become bent and appear only indistinctly. The narrowed tunnel space is filled with a homogeneous mass, which stains faintly with eosin, hence appears like extravasated cell contents. Nuel's space and the outer tunnel space are no longer present; the cells of Hensen are deformed, flattened out. Frequently a great space is found between the loosened hair cells and the curve of the cells of Hensen.

"These changes are all found immediately after the first shot and reach their height after two to three days. Then a regeneration process sets in slowly. Thus the organ of Corti is found already somewhat improved in the animals killed 8 days after the shooting. First the bent pillars straighten out and are recognized clearly. The hyaline mass in the tunnel is resorbed and the space itself restored. The hair cells, Deiter's cells and their supporting fibrils are not clearly differentiated in this stage of repair. The healing process does not proceed in all turns evenly; while the basal turn already shows a bettered condition the other turns show yet evident disturbances.

"In after days the regeneration process proceeds further, the cells of the sulcus spiralis externus and internus and the cells of Hensen take their previous form. The restoration of the hair cells and the Dieter's cells seems to be accomplished only very slowly and incompletely; for the animals killed 60 days after the shooting showed only in the basal turn

the hair cells and Dieter's cells in an improved, but nevertheless not fully normal condition, while in the remaining turns clearly differentiated hair cells and Dieter's cells cannot yet be demonstrated."

Yoshii further states that with repeated shooting day after day the degeneration proceeded until Corti's organ was replaced by a flat epithelium as in any noise deafness and in animals exposed for a long time to a single note. This severe change was limited to the region of the transition of the basal to the second turn. The tectorial membrane was modified in position and structure. The stria vascularis showed minor changes. In cases killed at once after the single shot blood corpuscles and free hemoglobin were found in the perilymphatic spaces. This was resorbed in time. The epithelium of the maculae and cristae showed a slight swelling. The ganglion cells and the nerve fibers of the same undergo very severe alterations, but in the single detonation cases the ganglion cells had at the end of 60 days returned to a nearly normal condition. In the repeated shooting cases, as in noise deafness, they completely disintegrated.

Many writers have given careful clinical descriptions of cases suffering from labyrinth commotion, and from the above account of the lesions in animals it is easy to understand the typical clinical picture. There is a sudden onset of deafness following the explosion nearby of a shell or mine. Frequently the man is rendered unconscious for a time and may be buried by the debris from the explosion. The deafness is usually total at first but may be either uni- or bi-lateral. It may or may not be accompanied by disturbances of the vestibular functions, indicated commonly by vertigo, nausea, staggering, etc. Subjective noises may be present. Marage reports that of 185 cases 82 per cent have blood pressure above normal. In contrast to the "tone gaps" and "islands" characteristic of noise deafness these detonation cases show a rather uniform degree of lowered acuity for all notes with a typical limitation of both ends of the tonal field. Wilson and West have both observed such cases associated with a concentric narrowing of the visual field.

As to prognosis, there is universal agreement that it is bad when the vestibular reactions are lost, and more unfavorable when the upper tone limit is lowered than when it is not; otherwise the prognosis in individual cases is very uncertain. Lannois and Chavanne report that the cases of pure labyrinth commotion, unassociated with middle ear injury, are most stubborn; of their cases 24% healed during the first month, 22% during the second month, 19% during the third month, 12% during the fourth

month and others as late as the ninth month. They state that of a total of 645 cases of labyrinthine commotion of all types only 2% remained bilateral definitive deafness and failed to improve to some degree. Lehman states that hearing returns in most cases in a month to six weeks. Wicart reports 95% as able to return to service when the only trouble was with the hearing, and believes that if he could have kept the cases longer the permanently disabled would have been reduced to 1 or 2 percent. Hurst and Peters say that the retention of vestibular functions with loss of cochlear is a differential diagnosis indicating a "functional" deafness; an editorial writer in the *Lancet* disagrees with them and rightly so, I believe, for there is plenty of evidence from animal experiments showing that severe cochlear alterations may occur without any vestibular changes to be detected by histologic study.

III. INJURIES TO THE CENTRAL NERVOUS SYSTEM.

Information concerning the condition referred to by many writers as "functional" deafness is very fragmentary. A consideration of the reports of many cases and the opinions of the observers indicates a division into two general groups; probably more divisions can be made as knowledge of the lesions increases. Mott has recently reported the study of the brains from two men who died of true "shell shock" (*commotio cerebri*). There was congestion and gross hemorrhage into the brain substance, with cellular changes in the grey matter. Cases have been reported of brains with microscopic punctiform hemorrhages which Mott says are similar to brains from cases of carbon monoxide asphyxia, which he accordingly considers to be the true cause of death. In such cases not severe enough to cause death it is conceivable and seems probable that either type of lesion may occur along the auditory paths and so cause disturbances of the functioning, very difficult, if not impossible, to differentiate clinically from the others but due nevertheless to such lesions as are known to occur elsewhere. A report by Guthrie of a man in civil life who became totally deaf following an apoplectic attack, but in whom no other function has been permanently interfered with, is of interest in this connection.

The second and larger group, in fact the only one recognized by most writers, is usually considered as hysterical in nature, and the causation as mixed psychical and physical. Deafness is only one of many forms by which the great nervous strain of modern

warfare manifests itself when the system gives way, aphonia and blindness being similar and fully as common as deafness and frequently associated with it. The nearby explosion is only "the straw that breaks the camel's back"; in many of these cases the restoration of function is as sudden as its disappearance. Treatment is directed toward overcoming the "fixed idea" that one cannot hear and various forms of surprise, suggestion and hypnosis have been most used when a spontaneous recovery did not occur in a short time. As to the lesions, Wilson and Hurst and Peters have suggested that one is dealing here with what Hurst and Peters call "unswitched" neurones. It is purely a theory; those proposing it assume that over stimulus or fatigue or some other factor may have caused a physical withdrawal of the dendritic contacts at the synapses, and that the sudden return of function is due to the impulse breaking across again and reestablishing the contacts. Wilson adds to this the view that at each synapse in the auditory pathway there is opportunity for the spread of the impulse to other neurone systems and that this dissipation of nervous energy may account for some of the hypersensitiveness of other systems when the auditory paths are blocked. These are very interesting theories but the general field of hysteria is one in which a great deal more work needs to be done before any positive statements concerning lesions can be made. To a morphologist it seems very improbable that any such functional changes can occur without having a structural basis, even though it is totally unknown now; therefore I have grouped these "functional" deafnesses with the traumas rather than as a separate group as is commonly done.

The writer of this review does not feel that a consideration of this subject is complete without reference to the feasibility of preventing many of the injuries due to air traumas. Information along this line has been very fragmentary and incomplete and accordingly the results in practice have been unsatisfactory. The literature on this phase of the subject up to May, 1917, was critically reviewed by the writer in a report submitted to the National Research Council at that time. He has since conducted and reported comparative tests, as yet unpublished, which indicate that certain devices are capable of preventing quite satisfactorily the occurrence of injuries of the detonation type, and it is probable that they would also decrease the rate of development of noise deafness while still permitting the hearing of ordinary sounds to such a degree that their use by troops is not contraindicated.

MISCELLANEOUS.

Aviators are subject to all the ear troubles of other combatants, and in addition have the factor of rapid barometric pressure changes during ascent and descent. Since these men are so carefully selected with reference to normal ears, as has already been referred to elsewhere, the opinion of the few who have written upon this subject is that beyond the sensations of temporary fullness and the resulting subjective noises no ill effects are suffered from this cause.

A consideration of simulated deafness is not within the province of this review; the subject is considered in many of the papers referred to, since the possibility always has to be kept in mind in handling military cases.

The question of pensions involves an accurate testing of the damage to the hearing and several papers have appeared upon this phase of the subject. They are listed in the bibliography, but no discussion of them will be attempted here; it is a matter specified by laws in most countries.

The reeducation of the hearing does not properly fall under the heading of the work to be considered in this review, but some of the papers that have appeared are listed in the bibliography, for it is a phase of the general subject that many will be interested in.

FOOTNOTES

¹ I desire to thank here Prof. C. L. Meader of this University for his kindness in translating this Russian article for me.

² The values of the condensations of the air for passing projectiles of various sizes and velocities may be known to physicists; time has not permitted me to learn if this is the case.

³ I have been unable to obtain a second paper by these authors that appeared in the *Paris Médicale* for March 10, 1917.

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INSECT VECTORS IN THE WAR.

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Of the insect vectors of infective agents, only three have proven of any importance in the present struggle, namely, the house-fly, the mosquito, and the body louse, and of these the importance of the body louse far outshadows the others.

THE BODY LOUSE.

The importance of the body louse arises from its role as intermediate host for the virus of typhus fever, for which it appears to be sole vector, and also as one of the intermediate hosts of the spirochetes of relapsing fever. Typhus fever has so far produced the most important epidemics of the present war, particularly the Serbian epidemic, which was without parallel in modern times. In general the outbreaks have been confined to the various eastern war fronts and to their vicinity, the Balkans, Galacia, Poland, and the camps of interned prisoners of war in Germany and Austria, particularly those camps receiving Russian prisoners. The disease has caused very little if any trouble on the

Western front, despite the fact that as much difficulty has been experienced there from lice as elsewhere. The difference is doubtless due to the fact that of recent years the endemic home of the virus of typhus has receded until in the days immediately preceding the war it was extremely rare outside of eastern Europe.

Typhus fever has from its earliest history always been associated with the misery and wretchedness arising from military operations, and similarly louse infestation has been recognized as one of the hardships of military life. Fischer⁴⁸ presents an interesting account of the early history of typhus and pediculosis, and states that the first observations upon pediculosis as a concomitant of typhus are given in a series of observations on Hungarian camp diseases, published by Tobias Cober of Gorlitz in 1606. His description of the annoyance produced by lice at that time is extremely vivid. The constant association of body vermin with the classes of people among whom the disease is commonly present, led Nicolle, Comte and Conseil, Anderson and Goldberger and Ricketts and Wilder, to suspect this insect as the vector of the virus. Their experimental demonstrations of this fact elucidated the entire epidemiological picture of the disease and indicated the means by which the disease could be controlled and eradicated.

The body or clothes louse, *Pediculus vestimenti* (syn. *humanus*) is an ectoparasite of man during its entire life and keeps fairly close to its host. The same is also true of the head louse, *Pediculus capitis*. The question as to whether these two represent distinct species is in dispute; the slight differences between them make a decision difficult, and it is frequently impossible to decide whether a given specimen is *capitis* or *vestimenti*. A very good account of the bionomics of the body louse is given by Warburton,⁵⁰ and also by Peacock.⁵¹ According to Bacot,⁴⁹ *P. vestimenti* is larger, more robust and less active than *P. capitis*. He has succeeded in crossing head and body lice and has obtained several generations of fertile females. The hybrids more nearly resemble the head louse. The body louse exhibits habits of gregariousness, especially during the moulting phases, and shows a preference for retiring to a particular spot to oviposit, which leads to a clustering of eggs. Female body lice prefer woolen fabrics for the attachment of eggs and avoid silk,⁵⁰ though eggs may be attached to the hair of the head, the same as with head lice. At moulting and egg laying time the insects try

to hide preferring the seams of the outer clothing, especially the crotch of the trousers.

Peacock⁵¹ has made extensive studies of the degree of louse infestation upon soldiers straight from the trenches on the western front. Thus of the men examined:

4.9 per cent were free from lice
41.9 per cent harbored from 1- 10 lice
19.6 per cent harbored from 10- 20 lice
14.7 per cent harbored from 20- 30 lice
11.2 per cent harbored from 30-130 lice
4.9 per cent harbored from 130-350 lice
2.8 per cent harbored 350 and more lice.

The most highly infested garments were the shirts, the trousers showing about two-thirds of this degree of infestation, while the number of lice on the socks are negligible. One infested shirt held 1,355 lice and 4,260 eggs and another 10,428 lice and 10,253 eggs approximately.

The dissemination of the lice occurs from either the infested persons themselves, their clothing, or their personal effects. The introduction of lice into the army appears to be due^{36, 51} to infested recruits or conscripts from verminous slums, from whom, after their introduction into service, the lice spread, through the absence of facilities for washing and cleaning. Hence the submission of all new men to delousing treatment as soon as received at a post or cantonment would appear desirable.

Hase⁴⁰ classifies individual susceptibility to louse infestation as follows: (1) individuals not infested with lice but living under conditions favoring their transfer and multiplication; (2) individuals who are sensitive to louse bites and retain their sensitiveness for long periods; (3) individuals who harbor lice, but who have developed a tolerance to the bites; and (4) individuals in whom biting never provokes disagreeable sensations. Individuals of groups three and four are particularly dangerous from the standpoint of louse dissemination.

Transfer takes place under the following circumstances: (1) the ordinary movements, especially dressing and undressing, dislodge lice from the underclothing to the outer clothing, or the spontaneous movements of the insects carry them to the outer clothing, from which situation they can readily become dislodged, and fall onto others, or be blown by the wind short distances to persons on the leeward⁴⁴ or become dislodged into the bedding or straw; (2) transfer effected by means of sleeping on bedding or

straw on which lice have become dislodged, or sleeping with an infested bed fellow; (3) intimate contact or association between individuals in close quarters, particularly when sleeping in those dugouts which are largest and accommodate most men; (4) instinctive migration of lice from person to person, which appears of trivial importance and (5) according to Bohme⁴³ lice may attach themselves to houseflies and be transported by the flies. The natural habitat of lice away from their human host is probably confined to bed and bedclothing, where the opportunities for re-attachment are good.

According to Peacock's observations,⁵¹ the dug-outs, billets and bivouacs, and also blankets are of relatively slight importance in the dissemination of lice, while the important factor is the lousy soldier himself. Ninety-five per cent of those who have seen six months service were lousy, the average number of lice per man being twenty, while about five per cent of the men are dangerous carriers, bearing over one hundred lice upon their persons.

Virgin female body lice commence egg laying within two or three days after their last moult and continue laying sterile eggs indefinitely or until fertilized. One male louse was observed to fertilize eighteen of twenty-one females. The females are more numerous than the males, as well as slightly larger. Following fertilization the female can lay fertile eggs for as long as twenty days, though sixteen days is the rule. The maximum number of eggs observed to be deposited from one fertilization was 115. During her entire life a female may deposit as high as 295 eggs at an average of 6.4 per day. The fertilized female head louse lays fertile eggs for about eleven days following one fertilization, depositing about seventy eggs during this time. During her entire life about 140 eggs may be laid at an average of four per day. A number of generations occur in the course of a year. Considering twelve days as the average egg period and a further period of twelve days to the maturity of the females, together with an average of eight eggs per day over an oviposition period of forty days, a single female body louse may have as many as 4,160 descendants.⁴⁹

In moist air at a temperature of 98° F., the eggs hatch within five days, at 87° F. in from 7 to 11 days, at 76° F. many died, while at 60° to 65° F. none hatched. The larval lice pass through three moults, the first in from three to five days after hatching, the second in from seven to nine days, and the third in from ten to fourteen days. Twelve days is about the average duration of

the various larval stages.⁴⁹ The larvae are more active than the adults. They defecate on the skin while feeding, while the adults defecate after they have returned to the clothing.

Newly hatched larvae live less than 24 hours without feeding when kept at 37° C. Without food the adults survive less than three days at the same temperature. Under favorable conditions, which includes a humid atmosphere and a temperature from 16°-20° C., the male louse may survive for as long as thirty-two days and the female for forty-six days.⁴⁹ Wiener⁴⁵ reports some living lice known to be at least seven months old. This observation concerning their temperature requirements probably explains the greater frequency of lice during the winter and spring months and their summer diminution, as well as explaining the observation of Wilder that louse infested persons coming from the plateau around Mexico City to the hot lands around Vera Cruz soon become spontaneously free from lice.

Lice eggs (nits) on clothing are difficult to destroy since they adhere closely to the fibers of the fabric, while the protecting envelope of the egg is very resistant to the penetration of chemicals. Widman⁴² states that in experimental work the best indication of the death of adult lice is the cessation of peristaltic movements of the intestine and in the egg by the wrinkling of the external envelope.

Bacot⁴⁹ raises lice for experimental purposes by placing eggs in small glass bottomed entomological boxes, the lids being removed and replaced by chiffon stretched across the top. The lice feed readily through the chiffon when placed against the skin. During the day the boxes are carried in the vest pocket and at night placed beneath a belt against the body for feeding. Bruno Heyman⁶ rears the eggs in sachets of silk carried directly on the skin. Widman⁴² says that lice will feed upon guinea pigs and mice after depilation and washing the skin with alcohol and ether followed by ammonium sulphate to remove the odor. He says an adult louse ingests from .6-1. milligrammes of blood at one feeding.

The maintenance of the louse population of the soldiery at a minimum is necessary, especially under conditions which make the employment of energetic wholesale measures of destruction impossible. This is especially true in trench life. Under these conditions, according to Peacock,⁵¹ the men should be encouraged to search their clothing daily for the adults. The daily catch may be expected to vary from eight to sixty, both old and young, the young lice caught hatching from eggs on the clothing, rather

than being immigrants. Arneth¹⁶ considers that no measures surpass this in importance and requires the men of his corps to search their clothing and bedding each night and morning, regardless of whether or not they are infested. Searching was also found useful in Gallipoli.³⁵ The vigorous brushing of the clothing, especially those parts most frequented by lice is recommended by Jean Legendre.¹¹

Physicians, nurses, and hospital orderlies should use great care when in contact with typhus cases previous to their delousing, to prevent the transference of infected lice to their own persons. The use of rubber garments and gloves is recommended.⁴¹ Those engaged in de-lousing a population among whom typhus is prevalent may protect themselves by wearing one-piece suits with rubber gloves, all openings in which together with the apertures for the neck, wrists, ankles, as well as the openings in the sleeves, are sealed by strips of adhesive.⁵²

Military activities usually render opportunities for the maintenance of personal cleanliness, including bathing and frequent changes of clothing difficult or impossible of achievement and create opportunities favorable to the multiplication and dissemination of these vermin. Under these circumstances the use of various substances in an effort to repel lice from the body has been quite extensive. The oily clothing⁵¹ of mechanics has been noticed to have this effect, while Hase⁴⁰ states that underclothes heavily soiled with sweat are repellent, as compared with clean clothes. Peacock⁵¹ finds that vermijelli ointment is very effective in repelling lice. This consists of crude mineral oil, 9 parts; soft soap, 5 parts, and water, 1 part, and is smeared once a week on all interior seams of the clothing. Marzinowsky, Popoff and Postrikoff² have utilized the action of nascent SO_2 , generated from a mixture of tartaric acid and sodium sulphite, which is moistened, placed in sachets and worn in contact with the skin. The body temperature facilitates the reaction. They state the wearer is not inconvenienced. Eysell³ advocates the dusting of powdered sulphur over the underclothing and on the inside of the outer clothing in the sites most favored by lice. The method is purely prophylactic and not curative. He considers it superior to naphthalene and states it remains effective for two weeks or more. Flowers of sulphur are stated to be ineffective for this purpose, while sulphur soap is also without effect. This is substantiated by Peacock.⁵¹ Various insect powders worn in sachets have been employed³⁵ with indifferent results. The anointment of the body and the allowing to dry thereon of a .5 per cent solu-

tion of lysol in 20 per cent soft soap is recommended.³⁵ Nocht and Halberkann^{17, 18} recommend global (powdered para-dichlorobenzol) worn in sachets carried on the body. They state it is cheap and not odorous. Two grams are placed in the sachets, two of which are worn in the trousers and one under either armpit. They also state that anisol is inefficient while cresol is better: Hase⁴⁰ tested out 181 substances and found most worthless. He affirms the efficiency of global, but says it blisters the skin, even when carried in bags outside the shirt, while clove oil is efficient but too expensive. Curshman²⁵ also speaks highly of global. Since lice try to escape from strong odors, Delta³¹ used cologne water containing a strong and lasting perfume and sprays the body from head to foot. He says he has controlled two epidemics of typhus by this measure. Various essential oils³⁸ bergamot^{29, 34}, anise^{30, 34, 42}, fennel^{30, 34, 42}, cinnamon^{7, 33, 34}, cloves^{33, 40} and eucalyptus^{28, 32} and ³⁴ have been used with considerable success, especially by the Germans. These are usually employed in from 10 to 20 per cent alcoholic solution. The N. C. I. powder has also given good results in the English army and will be discussed later, since it is not used as a repellent. Bacot⁶² finds that while naphthalene, sulphur, cresyl, iodoform, cystisine and vermijelli can be depended upon to kill lice with which they are brought in contact, their action at a distance is negligible. He recommends that the under clothing be soaked in cold water containing 5 per cent of an emulsion of approximately equal parts of soft soap and crude carbolic acid. Hase⁴⁰ states some soldiers rid their clothing of lice by burying it temporarily in ant hills.

The destruction of lice and their eggs on the body and clothing has been accomplished by a number of means. The N. C. I. powder is widely employed in the British army for this purpose. It is composed of naphthalene, 96 per cent; creosote 2 per cent and iodoform 2 per cent.²⁴ According to Kinloch²³ lice are killed in one-half hour by this mixture, the active ingredient of which is the naphthalene, of which the commercial product is best. He finds no substance superior to naphthalene for this mixture. The powder is dusted over the underclothing on the inner side of the outer clothing, at least once a week. Most effective results are secured when the men dust their clothes freely and roll themselves and their clothes tightly in blankets for the night. Tarassewitch³² recommends a mixture of phenol, 1; naphthalene, 1; turpentine, 9; and kerosene, 9. Wulker³³ considers naphthalene inefficient. Seel⁹ and Wesenberg¹⁰ advocate lausofane (cyclohexanone, $\text{CC}(\text{CH}_2)_5\text{CO}$), either alone or with cyclo-hexanol

($C(CH_2)_5CHOH$). After undressing the men impregnate the hairy regions of the body and the clothing with a solution of lausofane. Then the men take themselves and their clothing to an enclosed room and remain there from four to six hours, after which they bathe. The wounded or prisoners are taken directly to an enclosed room and the solution sprinkled directly upon their clothing, their beds and the floor, and the men spend the night with the fumes. This process cleanses both the men and their habitation. The fumes of mercury volatilized from strips of fabric impregnated with the metal which are worn around the body have been employed^{35,38}. Grünbaum²⁷ observed an outbreak of ptyalism among a number of Russian prisoners so protected. One-third of one per cent bichloride of mercury in vinegar is by Meuse¹ said to give good results in killing nits. Peacock⁵¹ found blue ointment useless when smeared on tapes placed around the extremities. Meierhof²⁶ recommends hydrogen peroxide to loosen the nits from hair. Von Marschalko⁵³ uses rectified oil of turpentine applied as a spray to destroy lice and nits in both the body and clothing. The hair is wrapped over night in a flannel cloth saturated with turpentine. Nocht and Halberkann,¹⁷ Soulina and Ebert⁷ and Kisskalt and Friedman³⁷ also recommend turpentine for this purpose, the last adding powdered pepper to the turpentine. Von Huff reports¹⁵ six cases of nitrobenzol poisoning arising from use of this substance as a vermicide. Lefroy¹⁴ advocates bathing the body and washing the clothing in the following: crude mineral oil (sp. gr. 0.8), 56 gm., black soap, 30 gm., and water, 6 gms. Orticoni⁴ and Dore³⁶ recommend spraying the clothing with 10% formalin, while the experience of Wulker³³ is in line with the lack of success that has generally followed the use of formalin as an insecticide. Pregl⁵ advocates soaking clothing in 25 per cent ammonia water for an hour, while the soldier bathes in ammonia water and soap. Wulker³³ and Fanyo³⁸ also find ammonia water very satisfactory. A strong solution of cresol, in naphtha soap^{29,7}, or water^{11,18}, is satisfactory, though Peacock⁵¹ finds one and one-half per cent cresol effective while Muto¹³ suspends the garments over a boiling 10 per cent solution of creolin. Sachets of cresol are recommended by Nocht and Halberkann.¹⁷ Various distillates are recommended. Xylol has proven effective^{7,33,34} and was used with naphtha soap. The immersion of clothing in a gasoline or benzine bath is highly recommended^{22,36}, or exposure in a tight vessel to benzene fumes^{50,34}, which destroys both lice and nits in 24 hours. Kinloch²² recommends the employment of an extractor, similar to

those used by dry cleaners, by which as much as 90 per cent of the gasoline may be recovered. Butler³⁵ smears on the clothing seams a mixture of soft soap and crude oil, a mixture similar to vermijelli. Nocht and Halberkann¹⁷ say that anisol is inefficient, while Fraenkel^{10,20} recommends anisol (methyl phenyl ether, $C_6H_5OCH_3$) highly, saying that it stupifies lice in four minutes and kills them in ten, and is very costly and slightly toxic for man, but does not irritate the skin. Galensky²⁹ employs a 10 per cent solution of anisol in carbon tetrachloride. Kinloch²² recommends immersion of clothing in water containing 2 per cent trichlorethylene or 10 per cent tetrachlorethan for 30 minutes and also the use of the same solution for bathing. Kulka¹⁸ also recommends trichlorethylene. Tetrachlorethylene, according to Kinloch²³ is less active than trichlorethylene, but is to be preferred to it for destroying lice on the scalp, since it is less irritant than the latter. The hair should be gone over with a piece of cotton moistened with ether, safeguarding the eyes meanwhile.

Rubbing with sulphuric ether is advised by von Prowazek.³⁴ The same writer³⁴ recommends a tobacco decoction (1 cigar to a liter of water) and Wulker³³ says tobacco fumes are efficient. Bupnik⁸ considers 10 per cent acetic acid superior to either ammonia or anisol, while Boyd⁵² employed vinegar and kerosene on the hair of Mexicans.

Kisskalt and Friedman³⁷ state that the odor of horses is repellent to lice, and that if lousy clothing is spread over horses for over night, the lice will leave, and states that the French cavalry in the Crimea were free from typhus. Hase⁴⁰ states there is no clear evidence which indicates that close contact with horses protects from or predisposes to lice.

Pressing infested clothing with a hot iron, giving especial attention to the seams and folds is advised by de Clerambault²¹, Peacock⁵¹, and Butler³⁵. Dore³⁶ advocates the pressing into the seams with a hot iron of a one-half per cent solution of ammoniated mercury in soft soap. Since according to Heyman⁶ eggs and nits are destroyed by heating to 80° C. for five to ten minutes; to Wulker³³ at 70° C. for 10 minutes; to Widman⁴² at 60° C. in five minutes, and to Bacot by exposure to 55° C. for thirty minutes, this provides a simple method for their destruction where ovens can be provided. Boyd⁵² employed an oven heated by steam coils to a temperature in excess of 160° F., maintaining this for twenty minutes. While submersion of clothing in boiling water for five minutes, or water heated to the above temperature and maintained at these points for the periods indicated is ef-

ficient, yet the use of dry heat saves time, inasmuch as no delay is caused by waiting for clothing to dry, while upon its return to the men it is warm and comfortable. Exposure of garments to steam for 20 minutes is satisfactory according to Legendre¹¹, to Prowazek^{30,34}, to Wulker³³, to Butler³⁵, to Peacock⁵¹, yet Legendre¹¹ calls attention to the difficulty often encountered in undertaking to supply a steam chamber in the field, while Bertarelli¹² states that clothing, especially where blood stained, may be rendered useless by steaming. The English have employed horse drawn thresh disinfectors for steam delousing. The so-called "Serbian barrel" has been used for delousing clothing by means of streaming steam. The details of construction and technique of operation are given by Lelean⁵⁴.

Sulphur dioxide continues to hold premier place as a fumigant for the destruction of lice and nits either in clothing or infested quarters. Meuse¹ liberates the gas by heating sulphurous acid to 40-50° C. and retaining it for four hours. He uses 5 kilograms of the acid per 100 cubic meters space. Legendre¹¹ says that SO₂ does not kill nits in which Prowazek does not agree³⁰, and Widman states it to be effective in fifteen minutes. Bertarelli¹² generates SO₂ by the Clayton apparatus, Nocht and Halberkann¹⁷, Zucher²⁹, Wulker³³, Prowazek^{30,34}, Butler³⁵, Kisskalt and Friedman³⁷, and Widman⁴² all consider the gas highly effective. Careful attention must be paid to the concentration of the gas employed and also to arrange the material to be deloused so that the penetration is facilitated and assured.

Friedman³⁹ considers that carbon bisulphide is superior to SO₂. He employs 100 c.c. per cubic meter and exposes it in shallow dishes and allows it to act for ten to twelve hours. Penetration is good and it is not injurious to furs. Those employing it must avoid inhaling the fumes and be careful of fire. Nocht and Halberkann¹⁷, Wulker³³, Kisskalt and Friedman³⁷ and Widman⁴² all speak highly of this substance as a fumigant.

Since adult lice die within five days without a meal of human blood, and since the nits hatch in from two to three days and die within a similar time if not fed, Fanyö³⁸ advises the closure of louse infested quarters for from two to three weeks, during which time all lice therein will have died. Infested clothing may be similarly treated.

Failures in the success of delousing measures have attracted the attention of many observers. Brauer⁴⁷ believes that this may be attributed to the survival of lice in the hair and advocates close clipping of the hair, while Fanyö³⁸ states that the cleansing

of a group of men requires that all infested persons be completely rid of lice simultaneously. Failure may also be due to eggs from which young lice hatch daily, that have survived methods of treatment fatal to young or adult lice.

The organization of systematic work for the delousing of large bodies of people is described by Lelean⁵⁹, by Peacock⁵¹ and by Boyd⁵².

THE HOUSE FLY.

The importance of flies as mechanical vectors of the typhoid bacillus and other infective agents contained in excreta, from excreta to food, was first forcibly presented in the Spanish-American and Boer wars, in which the high incidence of typhoid fever was shown to be very largely due to gross carelessness in the disposal of human excreta and the tolerance of conditions which permitted the breeding of flies. The further development of our knowledge of fly transmission largely took place prior to the present war, so that the importance of the subject is fully realized and adequate attention is given to the accepted and well known measures for its abatement. Careful attention to these details is essential, for on the various fronts the concentration of soldiers has been stupendous and in areas the progress is very slow, otherwise the conditions would readily favor the gross pollution of the soil with human excreta, and the breeding of swarms of flies.

Lelean⁵⁴ describes in detail the methods employed for the collection and disposal of human excrement along the western front. Reference should be made to this book for details. A considerable measure of success has followed the trapping⁵⁵ of the fly larvae as they leave manure piles in search of a suitable place to pupate. From the emptied tins which contain rations are fashioned the traps, by making small narrow slits on four opposite faces of the cans, filling them with gravel and burying them about the manure piles. Before burying the cans, bread crumbs, soaked in a mixture of .25 per cent formalin are placed in them to destroy young adults. Incineration of manure gives good results. Roubaud⁵⁶ calls attention to the fly menace to both the combatants and the civil population in the rear. In the cantonments the house fly is the chief pest to be attacked. As a fly repellent, he recommends spraying those situations chosen as sites of oviposition (manure piles, etc.) with heavy oil from coal tar, or a better liquid for this purpose, ferric sulphate, 2 kg. 500; heavy oil from coal tar, 500 cmc.; water, 10 liters. This is at the same time

deodorizing, larvicidal and repellent to adult flies. The heavy oil prevents the subsequent use of manure so treated as a fertilizer, since it is toxic for vegetation. As a substitute larvicide he recommends a 5 per cent solution of sodium cresylol, employing 15 liters per cubic meter of manure on the surface portions of the pile. To prevent the further laying of eggs on the pile, a 10 per cent solution of ferric sulphate should be sprinkled upon it, twice during the season.

In the trenches and the contiguous zone of combat, much annoyance is produced by the flies whose larvae are sarcophagous (*Calliphora*, *Lucilia*, *Sarcophaga*, *Pyrellia*, etc.) developing from the unburied or inadequately buried bodies of the men slain in combat. These flies have a greater radius of flight than the house fly. Roubaud⁵⁶ states that (1) means should be taken to prevent the access of these flies to corpses where possible, and (2) where not possible the bodies should be treated to destroy the larvae which develop. The coal tar oils assure the maximum protection, meat sprayed in this manner is free from larvae after 20 days, while when other substances are employed they are found after 48 hours. Good results are also given by ferric sulphate, employed either as a 10 per cent solution or as a powder. It may be used for either the temporary preservation of bodies exposed to the air, or at the moment of burial to destroy any ova which may have been deposited.

To the great pains taken in the collection of human excreta and the elimination of fly breeding places must be given a great share of the credit for the low incidence of typhoid fever and similar diseases along the western front. We are too apt to forget or ignore the importance of these measures and ascribe all the credit to active immunization.

MOSQUITOES.

Mosquito born infections have so far been of relatively slight importance in the world war, and malarial infections have been the most important of these. Various cursory references are made to the occurrence of cases among the soldiers operating along the Balkan front, and a few specific references have been made to the occurrence of isolated cases occurring among the troops in Flanders, which were apparently contracted upon the spot. The number of cases arising has been small. Among such references we may mention (57), (58), (59), and (60). The inundated fields of this region furnish ample facilities for the

breeding of Anophelines (the species most abundant is probably *A. maculipennis*) while the gametes are contributed by various white and native troops from the endemic centers of malaria in the Orient. Rankin⁶⁰ has observed both *A. maculipennis* and *A. bifucatus* in French Flanders. As far as may be judged from the literature these pests have not caused serious difficulty. For a general exposition of mosquito control from a military standpoint, nothing is better than Craig's treatise⁶¹.

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DISEASES CAUSED BY ANIMAL PARASITES.*

(CONSIDERED FROM THE STANDPOINT OF THE PRESENT

GREAT WAR.)

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INTRODUCTION.

Animal parasites have become a factor of unusual importance during the present great war. The transfer of troops, more especially from the tropics to western Europe, is responsible for a marked extension of the geographic distribution of many animal parasites. Camp and trench life is especially favorable for their dissemination. As a result, a large number of soldiers have become infected, and many have become incapacitated for military service for varying lengths of time.

The situation is of such importance that it has awakened the interest of parasitologists and stimulated the making of extensive investigations—not only with the object of maintaining the health of the soldiers—but of preventing as far as possible, the spread of animal parasitic infections to the civilian population.

In order to aid laboratory workers in the recognition of the more common animal parasites, Wenyon⁴⁸ has written a good article describing and illustrating the common intestinal protozoa of man.

Other articles of a similar nature have been presented by Woodcock⁵⁰ and also by Fantham and Porter¹⁸.

The investigations have also resulted in the discovery of several new species of animal parasites and of making other valuable additions to our knowledge of the subject.

The following represents a brief résumé of the more important contributions.

As evidence of the large number of intestinal parasites found in persons from western Europe who have seen service in tropical regions, Fantham¹⁹ presents the following figures for English soldiers who contracted diarrhoea while in Gallipoli:

* This paper represents a résumé of the contributions to the subject made during the period of the present war and considered from the war point of view. The insect vectors of disease are considered in another article.

No. of patients	1291
No. of patients in whom parasites were found.....	446
Total number of examinations made	3325
No. of examinations in which <i>Entamoeba histolytica</i> occurred.....	38
No. of examinations in which <i>Entamoeba coli</i> occurred.....	211
No. of examinations in which Noc's entamoeba occurred.....	2
No. of examinations in which Amoeba (<i>Vahlkampfia</i>) <i>limax</i> occurred ..	2
No. of examinations in which <i>Giardia</i> (<i>Lamblia</i>) <i>intestinalis</i> occurred	471
No. of examinations in which <i>Trichomonas hominis</i> occurred.....	2
No. of examinations in which <i>Chilomastix</i> (<i>Tetramitus</i>) <i>mesnili</i> occurred	1
No. of examinations in which <i>Cercomonas parva</i> occurred.....	2
No. of examinations in which <i>Coccidia</i> (apparently isospora type) occurred	4
No. of examinations in which <i>Spirochaetes</i> occurred.....	42
No. of examinations in which <i>Blastocystis enterocola</i> occurred.....	198
No. of examinations in which <i>Taenia embryos</i> occurred.....	1
No. of examinations in which <i>Hymenolepis embryos</i> occurred.....	1
No. of examinations in which <i>Trichocephalus</i> eggs occurred.....	3

Similar figures are given by Dobell¹⁴ and also by Roche³⁸.

AMEBIC DYSENTERY.

There is no longer any doubt but that the *Entameba histolytica* is the cause of amebic dysentery, although until recently many factors in connection with the life history of the organism and the modes of spread of the disease have been obscure. Craig⁸ has given us a good idea of the classification of the pathogenic amebae of man. The article is accompanied by an excellent bibliography.

Large numbers of British soldiers who went to Egypt, Gallipoli, and other regions near and in the tropics, contracted a diarrhoea of a dysenteric nature soon after arriving at these places. This led to the making of many examinations of feces and the finding of the specific amebae as reported by Dobell¹⁴, Findlay²⁰, and others.

Amebic dysentery carriers.—The continuance of diarrhoea in many of the soldiers for a long time even after they had returned to England caused repeated examinations of the stools, of both dysentery patients and convalescents to be made with the result that large numbers were found eliminating the cysts of the *Entameba histolytica*. In this way many carriers of these specific entameba were found by Fantham¹⁹, Dobell¹⁴, Waddell and Watson⁴⁵ and others.

Craig⁷ made a careful epidemiological study of an epidemic of 156 cases of dysentery which occurred among the U. S. troops who served in the El Paso district and punitive expedition in Mexico during the latter part of 1916. He concluded that carriers were responsible for the infection.

The carrier problem seems to be quite as important in connection with the dissemination of amebic dysentery as of the bacillary form. These carriers may be persons who have either recovered from the disease (convalescent carriers) or have never been affected by the disease (contact carriers). It is the cystic stage of the microorganism that occurs in carriers and is also the principal source of infection.

Walker¹⁶ found that 18 out of 20 men fed with the cysts of *Entameba histolytica* became parasitized, the average period elapsing between the ingestion of the material and the appearance of the entameba in the stools being six days. Of these cases, 4 developed typical entamebic dysentery. The remaining became contact carriers of the organism.

Treatment of dysentery patients and carriers.—The administration of emetin hydrochloride hypodermically seems to be quite efficacious in clearing away the symptoms of amebic dysentery and in ridding the intestine of the plasmodial forms of the *Entameba histolytica*. Recent investigations have, however, shown that in a large number of these cases the cyst forms of the organism continue to be eliminated and that there are many cases of recurrence of the disease. This may be due to the fact that these cysts are located in partly healed sinuses or pockets of the intestinal wall and for that reason drugs in the circulation do not reach them.

Du Mez¹⁶ found that the administration by mouth of a double iodide of emetin and bismuth was very efficacious in getting rid of the cysts in dogs.

These results were so good that its use in the treatment of human cases was tried and has been reported on very favorably by a number of English physicians. Thus, Dale¹¹ tried this treatment on ten persons all of whom continued to pass cysts after a course of hypodermic injections of emetin hydrochloride. Of these, six were discharged as cured, having failed to show any *histolytica* cysts as shown by daily examination for a period of six weeks. The others showed some improvement, but the course of treatment had to be discontinued because of the nausea produced.

Others who have secured favorable results are Low³², Inrie and Roche²⁵, Waddell and associates⁴⁵ and Lillie and Shephard³⁰.

The course of treatment as suggested by Dale and recommended by Low³² consists of the giving of 3 grain salol coated pills of emetin bismuth iodide every night for twelve consecutive nights. The salol coating almost eliminates the nausea which the uncoated pills produce in some patients. The coating of the tablets with keratin has also been tried but found less efficacious. Dale has suggested the use of one-grain pills of the emetin bismuth iodide every three or four days as a prophylactic in troops where the disease is endemic.

Dobell¹⁴ has shown that in cases treated by emetin hydrochloride subcutaneously, 70 per cent relapse, whereas, when emetin bismuth iodide is employed by the mouth this figure is reduced to about 10 per cent; or stating this as regards cures, only 30 per cent are cured by the former and 90 per cent by the latter.

Amebic dysentery may become a very serious problem in England and indeed, in all of the countries now at war. It is very important from the standpoint of both the individual and the communities concerned that carriers of *Entameba histolytica* be found and properly treated.

Low³¹ believes that if a person has once had amebic dysentery the stools should be thoroughly examined on several subsequent occasions to be sure that the carrier condition does not persist. He reports a case of amebic abscess of the liver which occurred 20 years after the original attack of dysentery.

Inman and Lillie²⁶ have found that 10 per cent of British soldiers and 24 per cent of Australian soldiers who were dysentery convalescents and who had returned to England from France were carrying *Entameba histolytica* cysts. They also found that the blood serum of 5 of 18 entameba carriers agglutinated the *B. dysenteriae*. They arrived at the conclusion that in cases of dysentery where the blood gives a positive agglutination test with dysentery bacilli it is not safe to let the case go unexamined for *Entameba histolytica* since the two kinds of infections may be present in the same individual.

METHODS OF EXAMINATION FOR ENTAMEBA.

The usual methods of examining feces for the plasmodial stage of the entameba are well known.

Rogers³⁹ has devised a good method of vital staining of ameba using neutral red in a dilution of 1-10,000. By this means

the entameba are colored a rose pink while the background remains unstained.

The recognition of the cyst forms of the *Entameba histolytica* is of very great importance more especially when searching for carriers.

Wenyon⁴⁸ advises the use of an iodine solution of double or triple the strength of Gram's iodine, *i. e.*, a solution of iodine 1 and potassium iodide 2 in distilled water 100 parts. A small particle of the stool is teased out in a drop of this solution on a glass slide, covered with a glass slip and examined by a weak diffuse light under the oil immersion. The nuclei of the ameba stand out distinctly and the central dot (karyosome) can usually be made out.

When specimens are stained by the iodine solution it is often difficult to pick out the cysts of the parasites because of the lack of color contrast between the cysts and the food debris which also takes on more or less of an iodine stain.

Donaldson¹⁵ has described a method of staining preparations which causes the cysts, more especially those of the entameba, to stand out very distinctly. The stain which he uses consists of:—

A. Five per cent aqueous solution of KI saturated with iodine to which is added an equal volume of either—

- B. (1) A saturated aqueous solution of rubin S; or
- (2) A saturated aqueous solution of eosin; or
- (3) Stephen's scarlet writing fluid.

A few loopfuls of one of the above stain combinations are placed on a clean slide, a loopful of feces taken and rubbed up with the stain to form a fairly smooth suspension, and a clean cover-slip gently lowered over the drop. By this method of staining the background takes on more or less of a homogenous red color "from which the cysts stand out as brilliant yellow or greenish colored spheres" and the nuclei of which stand out prominently as with the simple iodine method of staining.

Cropper and Row¹⁰ have suggested a method for the concentration of the cysts by emulsifying not less than one gramme of suspected feces in 30 c.c. of normal saline solution by shaking in a mechanical shaker in a large flask for at least 30 minutes. The emulsion is then shaken by hand for half a minute with 10 to 20 per cent of its volume of ether. On allowing this to stand most of the fecal debris rises to the surface and the cysts remain in the saline fluid. The saline fluid is then drawn off and cen-

trifuged at a low speed for two or three minutes. The cysts are concentrated at the bottom of the tube together with a comparatively small amount of fecal matter.

ENTAMEBA MINUTA INFECTIONS.

The *Entameba minuta* is rather generally regarded as a stage phase of the *Entameba histolytica*¹⁸.

James²⁷ who has recently given a good account of the entamebae of the Panama Canal zone is inclined to feel that it is a different organism and that it is the cause of a mild type of dysentery.

Woodcock and Penfold²¹ are inclined to the same view. They call attention to the fact that the cysts of the *minuta* usually have less than 4 nuclei. They place most stress, however, on the size of the cysts claiming that they have never seen the cysts of *E. minuta* larger than 8 microns, whereas cysts of *E. histolytica* are practically always 12 microns in diameter and that they have never found one less than 10.5 microns in diameter.

Roche³⁸ found this entameba in 29 of 893 cases of diarrhoea and dysentery among the troops of the Salonika war region.

Findlay²⁰ reports that 90 per cent of the Europeans who arrive in Egypt the first time suffer from a form of diarrhoea associated with gastric symptoms which is so common that it is often referred to as "Egyptian stomach." The first attack usually comes on within a fortnight of arrival in the country. Many of the cases are followed in the course of time by typical attacks of amebic dysentery. On examination of the stools of 110 cases, Findlay found the *Entameba histolytica* in 43 and *Entameba minuta* in 49 cases. It is not improbable that the mild cases of dysentery known as "Egyptian stomach" are caused by the *E. minuta* as distinguished from the *E. histolytica*.

LAMBLIASIS.

Until recently the *Lamblia intestinalis* was thought to have but little, if any, pathogenic properties. Recently, however, it has received considerable attention because of the frequency of occurrence of these parasites and the large numbers in which they are found. This, together with the fact that in many cases no other pathogenic organisms can be found, tends to indicate that it is pathogenic and that it is a frequent cause of diarrhoea of a dysentery nature. The parasites may be found either in the active flagellate or the inactive cyst form.

The flagellate forms are easily recognized since it is rather characteristic in appearance and usually occurs in considerable numbers. The cysts are well brought out by emulsifying the feces with a double strength Gram iodine as recommended by Wenyon⁴⁸.

Kennedy and Rosewarne²⁸ report 12 cases in which the history and microscopic findings suggest that the condition was dependent upon infection by *Lambliia intestinalis*. These were all cases from Gallipoli. All cases presented a dysenteric type of diarrhoea with passage of blood and mucus. The disease is of long duration,—the more acute symptoms varying from one to six months. A change to a cooler climate tends to cause the symptoms to subside.

Fantham¹⁹ found *Lambliia intestinalis* 471 times while making 3,325 examinations of feces of dysenteric patients. Dobell¹⁴ found them in 20 per cent of 135 patients with intestinal symptoms.

Roche³⁸ in an examination of the stools of 803 cases of diarrhoea and dysentery from the troops of the Salonika war region found the flagellate forms of the *Lambliia intestinalis* 29 times and the cyst forms, 44 times. He believes that the reason why the cysts are found more often than the flagellate forms is that the cysts are free and mixed up with the intestinal contents whereas the flagellate forms are dislodged with difficulty from the mucous membrane to which they attach themselves by their suckers.

Annie Porter⁵⁶ made a numerical estimation of the number of cysts of *Lambliia intestinalis* in certain cases of dysentery. This estimation was made by mixing certain definite quantities of stools with normal salt solution, then placing such in the chamber of a Thoma-Zeiss haemocytometer and making the count in the same way as blood counts are made. She found that the number of cysts per centimeter vary from 100 to 25,400. By taking into consideration the amount of feces passed she found that the total number of cysts eliminated varied from 10,000,000 to 14,440,000,000 in 24 hours.

Lambliasis is very resistant to successful treatment. Kennedy and Rosewarne²⁸ found that emetin given hypodermically was of no avail. Roche³⁸ was unable to find any treatment which would rid the intestine of these parasites. Woodcock and Penfold⁵¹ have, however, recently reported the successful treatment of two cases of *Lambliia* infection by the administration of betanaphthol together with bismuth salicylate.

The fact that lamblia infections have been found to be of frequent occurrence, that many of them become carriers and that the cyst forms are eliminated in very large numbers, will probably cause this disease to become rather wide-spread in regions which have heretofore been thought to have been free from infection with this organism. That this disease may not be entirely new to England, however, is suggested by the report by Smith and Matthews⁴³ of two cases of lamblia infection in soldiers who had never been out of England.

OTHER INTESTINAL PROTOZOA.

Trichomonas intestinalis.—This organism is of common occurrence; indeed it is the most common of the intestinal flagellates of man. There still seems to be some doubt as to the pathogenicity of this organism although recent evidence seems to favor the idea that it may at times be slightly pathogenic.

Mello-Leitao³³ believes that he has found cases of dysentery in children due to this organism.

Escomel¹⁷ reports the finding of 152 cases of dysentery in Peru, which he feels certain are due to the trichomonas. He also claims to have cultivated the organism and to have produced infection with diarrhoea in dogs by the injection of a culture.

Wényon⁴⁸ states that he has examined a section of the cecum of a mouse in which there was a definite ulcer of the mucous membrane the wall of which was being invaded by numerous trichomonas.

Tetramitus mesnili.—This flagellate is also commonly met with. Roche³⁸ found this parasite in 72 of 893 cases of diarrhoea and dysentery among the troops of the Salonika war region. It was the flagellate which was most commonly present in the specimens which he examined from this region. They were present more often in the flagellate than in the cystic stage. He believes that this is due to the fact that the patient's stool was examined soon after the diarrhoea commenced and before the slow forming cysts had time to develop. He did not find any treatment of avail in getting rid of these parasites.

The pathogenicity of this organism has not as yet been definitely proved. The tetramitus is best seen when feces are examined in a fresh state and before it has become cooled. Wényon⁴⁸ claims that the tetramitus survives in feces only a few hours, in which respect it is quite unlike the trichomonas which survive for days.

New intestinal flagellate.—Chatterjee⁵ has described what he regards as a new parasite in the human intestine. It occurred in a patient who was affected with dysentery. He says that the newly discovered parasite presents the structure of a trichomastix and that since this organism has not before been described as an inhabitant of the human intestine, he feels justified in referring to it as a new species—*Trichomastix hominis*.

Coccidia.—Coccidiosis has always been regarded as a rare condition in the human being. Woodcock⁵⁰ found coccidial cysts in 5 cases of 26 specimens of feces from English soldiers from Dardanelles. The cysts differ from those which have heretofore been recognized as pathogenic. They measure 42 by 14 microns. The membrane is definite and firm but rather thin. The cyst contains either one or two protoplasmic masses which are full of large granules. Since more than two of these masses have never been observed they are not regarded as segmentation stages of the eggs of higher animal parasites.

Woodcock regards these as belonging to the *Isospora* type—a type which is frequently found in cats and dogs.

Roche³⁸ found coccidia 18 times in examining the stools in 893 cases of diarrhoea and dysentery among the troops of the Salonika war region. He found that these parasites disappeared within a few days although in one patient they were found in daily examinations for three weeks.

Wenyon⁴⁸ reports the finding of three cases of coccidiosis at the London Hospital. He also describes the various changes occurring in the course of the development of the organism. Since this coccidium develops in the intestinal epithelial cells it must by bringing about their destruction, have some pathogenic properties.

Blastocystis hominis.—This peculiar organism which has been known for only a few years, is as the name implies, usually regarded as a plant belonging to the yeasts. This is the view of Wenyon.⁴⁸ He gives a good illustration and description of the organism. On the other hand, Woodcock and Penfold⁵¹ are inclined to regard it as a protozoon. These and others found it in practically every one of 384 specimens of feces of soldiers from the Dardanelles. It is apparently without pathogenic properties although Woodcock⁵⁰ reports one instance of diarrhoea in which it was apparently the only organism present that could account for the condition.

INTESTINAL WORMS.

Hook worm infection.—Uncinariasis will no doubt play a very important part in connection with the mobilization of troops from the southern part of the United States. Foster and Sinclair²¹ report that 39.9 percent. of 1,259 men from the Alabama National Guard were infected with hookworm. As a result of the transfer of the southern troops, hookworm disease will no doubt be introduced into many communities in the northern part of the United States and in Europe unless vigorous anti-hookworm measures are introduced.

Tape worms.—A few tape worm infections in soldiers have been reported by Fantham¹⁹, Stewart⁴⁴, and Borini².

MALARIA.

The transfer of troops from malarial regions has caused the appearance of the disease in many places from which it has been absent for a long time. Northern France was presumably free from malaria previous to the war. Recently, however, Dible¹² has reported the occurrence of malaria in English soldiers stationed in northern France. Rankin³⁷ reports that the examination of the blood of 200 soldiers in France showed the presence of *P. vivax* in ninety-three and of *L. malariae* in four. He also found mosquitoes which are capable of transmitting malaria. Inasmuch as the Flanders region is a flat, low-lying country interspersed with canals making it very favorable for the development of mosquitoes it is exceedingly important that rigid anti-mosquito measures be adopted before malaria gains too much of a foothold.

Zweig and Matko⁵² state that malaria is on the increase in the Austrian army. They also report that the use of quinine as a prophylactic does not seem to be as effectual as it had heretofore been presumed to be.

Healthy malaria carriers seem to be numerous. Garin²³ examined the blood of a large number of apparently healthy soldiers on the Macedonian front during the months of July and August, 1916, and found that about 70 per cent of them were infected with the malarial parasite. Garin concludes that in malarial districts most people are infected and that clinical malaria is of relatively rare occurrence. Evidently a person may be infected with the malarial parasite for a much longer time before the appearance of symptoms, than we have been inclined to believe. Garin believes that the use of quinine as a preventive merely retards the appearance of clinical symptoms. Mitzmain³⁴ concludes after an

examination of 2,122 dissected anophelines collected in the state of Mississippi and from the examination of the blood of 1,184 persons residing in the same district, that man is the winter carrier of the malarial organism. He did not find any of the parasites in the hibernating mosquitoes but found that 492 or nearly one-fourth of the persons examined harbored the malarial parasites in the gametocyte stage.

KALA-AZAR.

This serious disease which is rather common in the tropics is making its appearance among the soldiers who are returning from the tropical regions. Ward⁴⁷ reports the occurrence of several cases of the disease in soldiers who returned from Malta. Other European cases are reported by Rogers and Hume.³⁹

The most significant recent contribution to our knowledge of kala-azar is the apparently successful treatment of the disease by preparations of antimony. The success seems to be so marked as to regard it as a specific. It is given intravenously in the form of tartar emetic beginning with four to six centigrams on alternate days and increasing the dose by one or two centigrams every other day up to a maximum of twenty centigrams. It appears that Cristana and Coronio⁹ were the first to publish cases of the successful use of this treatment. Rogers, however, claims that the treatment was used by him previous to that time. Details of the method of treatment are given by Rogers and Hume³⁹. Recently Rogers⁴¹ reported the cure of every one of thirty-five cases of kala-azar in Europeans who received the treatment.

BILHARZIOSIS

Morel³⁵ states that all Africa, the eastern shore of the Mediterranean, the Asiatic shore of the Indian Ocean and parts of Australia, are known to be infected with the *Schistosomum hematobium*. The transfer of troops is bringing the disease to Europe. Morel encountered four cases of the disease in Paris.

Gabbi²² reports the finding of several cases of Bilharz disease in Italy. It had not been recognized in that country previous to the war.

Clapier⁶ states that more than 50 per cent of the inhabitants of the military district of Guinea which is situated on the frontier of Liberia are affected by bilharziosis. Because of the indifference of the inhabitants to the symptoms of the disease the extent of the infection was not known until a systematic search was made.

OTHER DISEASES.

Filariasis.—Gabbi²² reports that filariasis was not recognized in Italy until after the beginning of the present war.

Trench fever.—Dimond¹³ reports the finding of a small hemogregarine in the blood of 12 cases of trench fever. If this organism is found to be the cause of this disease it is quite likely that it will be found to be transmitted from rats to the human being through the bite of lice.

LABORATORY TECHNIQUE FOR MICROSCOPIC EXAMINATION

The details for making the usual microscopic examination of both unstained and stained specimens is discussed by Wenyon⁴⁹ and also by Woodcock⁵⁰ in articles in which they give descriptions of the intestinal protozoa.

Methods which are especially applicable for the recognition of entameba and their cysts have already been taken up in reviewing the literature on amebic dysentery. The use of the strong iodine solution seems also to have been very valuable for the finding of the cysts of flagellates.

Carles and Barthelemy⁴ give the following method of concentrating intestinal parasites including the worms and their ova, and the protozoa in both the active and encysted forms:—

1. Take 20 grams of feces and dilute such with physiologic salt solution containing 10 per cent formol, to render the feces fluid and homogeneous.

2. Pass the diluted feces through a wire or silk sieve to remove the more coarse particles. A silk sieve which has 90 threads to the centimeter (No. 90) or for the ova, a No. 32 may be used.

3. Place the sieved fluid in a centrifuge tube and centrifuge at 1800 turns for one minute.

4. Decant the supernatant fluid and treat the sediment with a mixture of citric acid—12 grams; saturated solution of formaldehyde 2 c.c. and water 86 c.c.

5. Add 1 or 2 c.c. of ether and shake tube briskly to detach sediment.

6. Centrifuge for 30 seconds at 1800 revolutions.

7. Break up any film that may have formed at the juncture of the ether with the remainder of the fluid by means of a glass rod.

8. Centrifuge again for 30 seconds at 1800 revolutions.

9. Decant supernatant fluid.
10. Transfer the sediment to a slide and make microscopic examination.

The foregoing résumé of the recent contributions made to the subject of diseases caused by animal parasites indicates very clearly that the present war conditions are leading to a wide dissemination of many parasites which have heretofore been practically limited to the tropics. It is very obvious, therefore, that physicians generally, and laboratory workers more especially, should familiarize themselves with the means of diagnosing the diseases in question.

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THE VENEREAL DISEASE PROBLEM AND THE WAR.*

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Whatever may be the extent of the damage accruing to society from the Great War, it is not too much to say that by the impetus which it has given to thought on the problem of venereal disease, it has already accomplished much good. An aroused public opinion will now demand action instead of silence or indifference to the knowledge that 15 or 20 per cent of a population is syphilitic and 70 per cent of males have had gonorrhea at least once in a life-time (Pusey, Stokes). In the last three decades, Europe has slowly passed from the mediæval laissez faire on this issue to at least a working conception of public policy. Progress has been delayed not only by the tendency to ignore the condition but by the unfortunate confusion of an issue of public health with one of public and private morals. The effect of making the problem of venereal disease merely an appendage of the problem of unsocial sexual relations has been to involve a relatively simple issue in the endless coils of debate and controversy which have for centuries whirled about the so-called social evil. Unlimited energy has been frittered away on the Continent, in France and Germany particularly, in the struggle between regulationists and abolitionists (Bloch, Flexner, Kneeland). Good has of course, come of the ventilating of this aspect of the problem, but the fact that the whole issue has been revived by the present war, and that two radically different types of program have again come to the front is the best evidence that the formula for the control of venereal disease does not lie solely in the application of special measures of any type to the single issue of prostitution.

Credit must be given the Scandinavian countries for first incorporating into legislative form what are now conceded to be the basic essentials of a public health campaign in this field. Around the nucleus afforded by the special codes of Denmark, Norway and Sweden, opinion has gradually crystallized in the years immediately preceding the war, to the point where two groups of issues may be distinctly recognized. The first group includes those essentials which are accepted virtually without debate by every country pretending to have a public policy. The

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second group includes the issues still under discussion at the outset of the war, and the points on which the two great types of national policy may be said to differ.

GROUP I

1. Provision of universally available, reliable means of early diagnosis by the state.
2. Provision of universally available and efficient free treatment by the state.
3. Limitation of treatment to competent hands, suppression of quackery, drug-store prescribing, advertising cures and patent medicines.
4. Moral and educational prophylaxis.

GROUP 2

1. Suppression or regulation of prostitution.
2. Dissemination of knowledge concerning venereal prophylaxis, and sale of the agents employed for this purpose, to the public at large.
3. Compulsory measures and penalties making treatment obligatory on the patient until he is cured, with or without preservation of his secret.
4. Reporting of venereal disease in open or anonymous form, to the health authorities.
5. Indirect legislation bearing on transmission of infection in or out of marriage, professional medical confidence, marriage laws, etc.

Legislation exemplifying the first group of principles to the exclusion of the second is typified by the recommendations of the Sydenham Royal Commission, as put into effect by the Local Government Board of Great Britain on July 12, 1916, and supplemented by the Venereal Diseases Act of May, 1917. In spite of the fact that the pressure of two years of war might well have brought home to the British public a sharp enough realization of the need for it, the Commission and its successor, the National Council for Combatting Venereal Diseases, have refused to take a stand even on the least mooted features of the second group—compulsory treatment for the irresponsible. The detail of the provisions includes special wards in general hospitals for the treatment of venereal disease, free institutional treatment, evening clinics for the laboring classes, the gratuitous supplying of salvarsan or its substitutes to general practitioners, extended lab-

oratory facilities, including those of hospitals and universities now in existence. Seventy-five per cent of the cost is to be borne by the imperial government, and 25 per cent by the local government funds.

Another obviously direct offshoot from the parent type of legislative program represented by the Denmark code of 1906 is found in the West Australian enactment which went into effect as an amendment to the health law of that province December, 1915. This program is more radical than the British, in that in addition to Group 1 principles, it adopts the compulsion-features of Group 2 with a vigor which promises well for their fulfillment. So long as the patient obeys the law and remains under competent care, his confidence is protected.

Both these programs have attracted very favorable comment in this country. They are typically Anglo-Saxon, it would seem, the Sydenham one especially so in its respect for the inalienable rights of the individual. They are commendably conservative, and do not outstrip the reasonable support of the type of public opinion on which their effectiveness will rest. The principles incorporated are basic, and programs of this type do not give the impression of being colored by the military opportunism which seems to have influenced the trend of more extreme measures in Continental Europe. While the British Commissioners make recommendations on the moral prophylaxis of venereal disease, they are careful to keep their policy off the rocks of regulated versus segregated prostitution which would founder it in conservative British opinion. Such legislation in peace times would be ideal, and might well serve for a pattern to our own country, which has not and may not feel the full pinch of war. The legislation is essentially a civil rather than a military program, and it remains to be seen whether it can meet the exigencies of war without patching or stretching. The emphasis is primarily on cure rather than prophylaxis, and as such it operates on less debatable but at the same time less progressive ground.

The venereal programs of Europe have not been brought to the attention of Americans with the definiteness of the British and Australian laws. Information in regard to them is less available. The French Academy commended to the Government a set of resolutions urging education as to the value of continence, medical examination of colonial troops, redoubled police supervision of rooming houses and hotels, repression of soliciting, the use of prophylaxis by men exposing themselves, the training of physicians in syphilology, and the limitation of treatment to the

hands of competent men (Gaucher and others). In an earlier series of recommendations to the War Department (Cole), the regulationist flavor was strongly apparent, and includes surveillance and bi-weekly inspection of tolerated houses of prostitution and registered women, visits by the military authorities, and the exclusion of women not natives of the war zone without military pass. The formation of special venereal hospitals both for military and civil cases, with out-patient departments, special clinics for the instruction of military officers, and provisions for the instruction of troops are certainly basic requirements, but to what extent they have been carried out outside the war zones, and what benefit the civil as distinguished from the military population has received from them, it is impossible to ascertain. French soldiers are supplied with a leaflet instructing them with reference to the desirability of continence and the resort to prophylaxis if they fail to live up to it (Cole). A comprehensive view of the French conception of a national program applicable to the present needs of the country may be obtained from Balzar's articles.

The Italian public program antedates the English and like it began in a Scandinavian type of provision for public treatment, without compulsory features, inaugurated in August, 1907. The dispensaries were organized by the communes in co-operation with the Ministry of the Interior (Flexner). Very little has been heard of the operation of this system in connection with the war. Schwiening's figures show that up to 1903 there had been an excessive venereal morbidity in Italy's armies,—the highest in Europe. In the present war she has rapidly passed from the principles of Group 1 to those of Group 2 and now has formally recognized houses of prostitution as army institutions, in imitation of Japan in the Russo-Japanese war, and carries out her army prophylaxis in connection with them. An unusual degree of success is claimed for the combination. De Napoli apparently urges the extension of the system to the country at large. Here, as in the case of France, regulation had ridden into public policy on the shoulders of supposed military necessity. In Italy, as in France, the first steps toward an initiation of the public into medical prophylaxis are being taken in the form of public lectures by authorities such as Stanziiale of Naples.

To Germany apparently belongs the distinction of having during the period of the war, incorporated into her public policy a greater number of radical features than any other country, and of having carried them out with the attention to detail character-

istic of her administrative method. In Germany, as in other parts of continental Europe, the confusion of prostitution with the sanitary issue of venereal infection and the regulation-abolition controversy had subverted much of the best thought on the question. An exceptionally well-informed type of sentiment had developed, however, especially through the activities of the Deutsche Gesellschaft für Bekämpfung der Geschlechtskrankheiten. German troops had for a number of years had the enviable distinction of the lowest admission rate in the world for venereal disease. None the less, a prospect of a considerable rise in a foreign campaign was foreseen, and a vigorous discussion was carried on throughout Germany and Austria, contributed to by such men as Neisser, Blaschko, Finger, Lesser, Zieler and others, as to the proper policy to be pursued under the circumstances. Blaschko opposed a policy of regulation of prostitution on the score that it would be futile when, as was well known, a woman might receive as many as forty clients a day. Neisser for the same reason urged indiscriminate treatment especially for syphilis, of every woman known to have illicit relations with soldiers, whether or not her infection could be proved. It was proposed to intern in concentration camps or otherwise imprison all women found to be infected, and an order of v. Hindenburg's gave effect to this recommendation, June, 1915 (*Lancet*).

In a recent report from Swedish sources (Fønss) it is stated that Hecht has even proposed the introduction of a central bureau of supervision of prostitution, on the lines of the Gøteborg system for controlling the liquor traffic, by making it profitless. The disgruntlement of abolitionist forces, as expressed in translations made for the *Journal of the American Social Hygiene Association*, indicates that a regulated prostitution is in force in military districts, although this was occasionally denied in the earlier months of the war. Compulsory treatment, and reporting to the health authorities, both features of the second group of provisions as described, were suggested in the recommendations of the Munich Medical Association, with the expectation that violent opposition would be aroused. A central bureau for the management of this work on a national scale was recommended. The latest report, through Scandinavian sources (Fønss) that a special committee of the Reichstag has recommended the notification by name to the authorities of infected persons, with abrogation of professional secrecy when a venereal disease is involved, and the subjecting of all physicians examined by the state, to special questions on venereal disease, in order to oblige them to

inform themselves on the subject. The provisions on reporting are indeed, as compared with other programs, radical enough to deserve the British *Lancet's* description of "dragooning."

Germany's attitude on prophylaxis has gone to lengths unknown in other countries. The earlier opposition to the dissemination of such knowledge on the score of moral objection and of the effect of contraceptive agents employed as preventatives of venereal disease on the birth rate, was submerged in the demand that every possible means be taken to prevent the spread of disease as the more costly of the two evils. Neisser even recommended that condoms be freely supplied to soldiers, and knowledge as to the Metchnikoff prophylaxis seems also to be widespread.

In its preparation for the control of venereal disease in the civil population, especially in connection with the discharge of men from the army, Germany at the present time seems to lead the world. Advisory clinics or *Beratungstellen* are being established to advise and oversee the patients referred to them by the army. At the last report 73 special clinics had been established by insurance companies in Prussia. The *Reichsversicherungsamt*, in co-operation with the special dispensaries of the insurance companies, is making plans to provide every syphilitic person with not less than three years' efficient treatment, and life-long observation if necessary. Appropriate provision has been made for the management of gonorrhoea so as to protect the population (*Lancet*).

Data on the Austrian policy are not abundant, but they seem to indicate that the policy is essentially German, with special emphasis on the regulation of prostitution. A follow-up or check system for infected Austrian soldiers is in force (Hecht).

Summarizing the European situation, the war has seen England and one of her dependencies,¹ embarked formally on a program commendable for its strict adherence to broad essentials, and its regard for basic principles and moral values as they affect a people as a whole. While this plan still lacks many of the details both of conception and execution which will be necessary for its successful working, it is on the whole a model to be followed in its effective handling of curative as distinguished from preventive measures. The programs of other European nations have developed more rapidly than the British in the direction of

¹ A personal communication by Detweiler of Toronto indicates that a code similar to that of West Australia has been proposed for Canada.

the less widely accepted features of a public campaign (Group 2). There seems to be a strong element of military necessity pervading the general adoption of regulative measures for the control of an officially sanctioned prostitution, and a general belief that a regulated prostitution combined with prophylaxis is less dangerous than an uncontrolled prostitution (Neisser). It is difficult to find any evidence that systematic and complete repression of commercialized prostitution has had serious consideration as a program in France, Italy, Germany or Austria, or indeed in England, apart from the measures taken to punish the wilful transmission of venereal disease, to suppress street soliciting and for the internment of infected individuals. 'May explicitly states that the British situation is most unsatisfactory and that nothing is being done to keep loose women away from military centers, although under the Defense of the Realm Act adequate powers exist. Widespread ignorance and the urgent need for educational measures for both the medical profession and the public as to the dangers of the situation is urged on all sides. An extreme radicalism by Anglo-Saxon standards characterizes the steps taken in Germany and Italy to popularize medical prophylaxis. Germany's position, according to available reports, is far in advance of any other nation in the provision made for the development of a true national venereal service, and for the protection of the civil population after the war, although so far as her home population is concerned, England will probably find herself a close second in equipment if not in means of enforcement by the end of the war.

The position of the United States in the world-wide movement against venereal disease is in some respects not altogether an enviable one. Our public campaign has scarcely developed beyond the point reached by that of England in 1898, at which time the first concerted effort was made to bring venereal disease to the attention of Lord Salisbury, the then Prime Minister. Thus far Congressional legislation on the subject of the venereal situation seems to be confined to the Weeks bill for the protection of the army and navy from prostitution, and the clause in the omnibus bill on trading with the enemy (Adamson Act), which now permits the manufacture and marketing, for the time being, of salvarsan substitutes in this country. National policy has not existed for us heretofore, our restricted activities developing in characteristic fashion through the local initiative of cities and states and of private agencies. We had scarcely progressed even in this direction beyond the performance of Wassermann tests

and the occasional examination of smears. Quasi-successful vice repression and state experiments in indirect legislation, too often freakish and premature, were the rule, although notable advances had been made by one or two states, particularly Michigan² and Ohio.³ Notification, being cheap and easy of enactment, outstripped in popularity the provision of facilities for treatment. Deplorable conditions were found among private institutions in New York on the eve of the war (Barringer and Platt), and there is no reason to suppose that the facilities of other cities were any better. Here and there certain city health officials with commendable zeal, enforced compulsory measures against irresponsibles with the aid of antiquated laws, or tried with limited means to build up treatment and diagnostic facilities, which however, showed a marked leaning toward the Wassermann at the expense of the dark-field and the clinical expert. Thanks to the stimulus which is being given the movement against venereal disease all over the world, an awakening is at last in progress. The recent enactments and appropriations made by the state of California are a miniature of a program which might well be given national scope by the Federal Government, since it is hardly to be expected that state activity, however commendable, will meet a situation in which other nations are finding their utmost efforts inadequate.

Our embryo policy, undirected by any precedents of a national scope, has at the very outset had to confront the domination of military opportunism whose influence is so apparent in Europe, with the risk that for an indefinite period the movement against venereal disease might be subservient only to the needs of the army and navy, and that in the bending of all organization to that end, the vast problem of venereal disease in the civil population outside of military zones would, for the time being, be forgotten. Even more serious results might have followed this subservience to the military. Instead of a mature and well thought out policy applicable as the British policy is, to the nation as a whole, we might easily have fallen into a régime of regulated and institutionalized prostitution seemingly so closely associated

² Act No. 274, Public Acts of 1913; Act No. 153, Public Acts of 1915. These enactments provide for the treatment in the University Hospital at Ann Arbor, of patients who can be benefited by such care but cannot meet its cost.

³ Amendment to Section 1275, General Code, P. 177, provides for the waiving of the obligations of professional confidence where a venereal disease is about to be transmitted.

with militaristic organization. We might have waived with it the power to choose our course on the basis of moral rather than political expedients. The United States is fortunate in that it has in this matter, as in others connected with the war, refused the easier course and deliberately undertaken the enormous task of putting a moral principle into effect by the suppression of prostitution wherever our forces are concerned. We owe the fact that we are so definitely committed to this ideal, to the influence of a nucleus of well organized opinion conveniently near the seat of action which in the earliest days of the war addressed itself to the sympathetic ear of exceptionally high-principled public officials. These officials had, in the Mexican mobilization presumably, had abundant opportunity to appreciate the revolting degradation of the opposite course. The energy absorbed in the protection of the military and naval forces of this country should not, however, be allowed to bring about a neglect of the public health campaign for the country at large. Thus far the effect of the war seems to have been to stimulate local initiative. It is to be hoped that the Federal Government itself will take steps to organize a civil campaign on a national scale, as an accessory to that conducted in the interest of the army and navy.

In the history of venereal disease in its relation to the armies and navies of the world, two facts are of outstanding importance: First the increase in the incidence of venereal infection during war times, and second the efficiency of modern medical prophylaxis in combating the venereal morbidity of an army. In order to appreciate the bearing of these facts on the war one should review briefly the comparative standing of various armies with respect to the admission-rate for these diseases per thousand men per annum. Chart 1, from Colonel Lyster's valuable article, summarizes the situation in the United States Army from 1888 to 1915. The effect of isolation in the small towns and posts in the West, the absence of inspection, Wassermanns, etc., and the tremendous rise coincident with the venereal baptism of the Spanish-American war is apparent. The effect of foreign service in increasing the venereal rate is evident in the difference between the rates of continental and total forces. Not only are the rates higher in foreign service in most armies, but Europe is finding the high rates of colonial troops a menace. Venereal prophylaxis came into existence following the studies of Metchnikoff and Roux, and the scandalous morbidity both of American and European troops led to the early application of its principles to the

conditions of army life. Individual experiments were co-ordinated for this country by the Surgeon General and their systematic application begun in the period from 1909 to 1911. The rapid reduction in the admission rate during the ensuing years is one of the most striking tributes to the possibilities of prophylaxis that could be imagined. Chart 2 compares the venereal morbidity of the American Army from 1888 to 1915 with that of the Prussian Army from 1867 to 1910, in irregular periods. The figures are Schwiening's. During the Franco-Prussian war the figures were considerably higher. Those of the first Bavarian Army Corps rose from 10.2 to 77.7 per 1,000 from January to May (Finger). In spite of this, the unenviable position of the United States at this time is apparent. The Surgeon General of the Army, in calling attention to our status in 1910 and urging the vigorous pushing of prophylactic measures, gave the following as the figures then obtainable for the comparative rating of European nations.

United States Army.....	155.5 per thousand per annum
British Army at home.....	68.4 per thousand per annum
British total	75.8 per thousand per annum
Austro-Hungarian	54.2 per thousand per annum
French at home	27.8 per thousand per annum
French total	34.8 per thousand per annum
Prussian	18.7 per thousand per annum
Bayarian	15.2 per thousand per annum

The British Army has, for a number of years, shown a steady decline, although the admission rate in 1888 was 224.5. In 1900 it had fallen to 93 when a large part of the regular army was in South Africa (British Medical Journal). This was followed by a rise to 131 in 1903 when the troops had returned home. The rate further declined to 82 in 1906 and to 75.8 (total) in 1910. This decline has apparently been maintained in spite of the tremendous increases in the British Army during the present war. No satisfactory recent antebellum figures for the armies of other nations involved in the war have been obtainable (Figures are given up to 1908 by Schwiening).

It is apparent from these comparisons, that our antebellum status with reference to venereal morbidity has at no time been a credit to us in comparison with either Great Britain or Germany. In comparing war conditions, however, the writer makes allowance for the fact that he has no figures suitable for comparison covering conditions in French, Austrian or German

armies, or the period of British mobilization and training, which in every army is one of special difficulty and high rates.

The available recent figures on venereal morbidity in the British Army have been cited—48 per 1,000, Nov. 16, 1916, and 43.5 per 1,000, Feb. 27, 1917. The Italian figures are 90.5 per 1,000 up to Dec. 31, 1915 and 46.2 from January to June, 1916 (Balestra).

Many nondescript types of estimates are cited in the literature among the French. Those of Gaucher and Bizard and Perrin are merely the statistics of hospital services. Thibièrge (quoted by Gaudy and by Cole) estimates that in the French armies between 4,000 and 5,000 contract syphilis each month or 50,000 to 60,000 a year—a total for the three years of the war of 150,000 to 200,000 new syphilitics in France alone. Gaudy cites Balzer's statement that up to the end of Feb., 1915, 30,000 cases of venereal disease had developed among German troops in Belgium. For Germany, Blaschko is credited with the estimate that with a rate of 40 per 1,000 and an army of 7,000,000 men, 280,000 fresh cases of venereal disease would develop annually, of which 60,000 would be syphilis. Indirect Austrian estimates (Moldovan) indicate a rate of 40 per 1,000. Most of these figures merely indicate the magnitude of the problem and have little comparative value.

TABLE I.

VENEREAL DISEASE.

Disease Conditions Among Troops.

Jour. Am. Med. Ass'n.

1917	ADMISSION RATES, WEEKLY			ADMISSION RATES, ANNUAL	
	REGULAR ARMY	NATIONAL GUARD	NATIONAL ARMY	U. S. CONTINENTAL ARMY	
Oct. 12	51.6	106.2	204.8	1905	178
Oct. 19	77.8	118.3	146.4	1906	158
Oct. 26	63.0	134.5	138.7	1907	167
Nov. 2	90.4	93.6	135.6	1908	174
Nov. 9	83.5	151.5	115.3	1909	177
Nov. 16	94.3	74.0	95.3	1910	155
Nov. 23	146.1	68.0	69.0	1911	163
Nov. 30	97.4	100.7	104.3	1912	115
Dec. 14	69.7	44.6	74.3	1913	85
				1914	89
				1915	83
				1916	91

TABLE 2.

ADMISSION RATES IN THE UNITED STATES. (JOUR. AM. MED. ASSN.)

	Regulars, United States Army in the United States only. 1916.	Regulars in the United States week ending Oct. 12, 1917.	National Guard. All Camps and Departments, week ending Oct. 12, 1917.	National Army. All Camps, week ending Oct. 12, 1917.
	CASES RATE	CASES RATE	CASES RATE	CASES RATE
Annual rate per 1,000...	613.00		910.8	1043.4 994.7
Pneumonia	2.59	6	1.4	30 4.3 50 6.0
Dysentery	3.97	4	0.9	49 7.1 8 0.6
Malaria	12.52	20	4.8	97 14.2 48 5.8
Venereal	91.00	214	51.6	660 96.7 1689 204.8
Paratyphoid.....	0.31	1	0.2	0 0.0 0 0.0
Typhoid	0.21	0	0.0	4 0.5 2 0.2
Measles	20.29	88	21.2	263 38.9 104 12.8
Meningitis	0.29	2	0.4	10 1.4 3 0.3
Scarlet fever	0.59	8	1.9	6 0.8 1 0.1

For the United States during the present mobilization Chart 3 shows the published weekly reports of the Surgeon General's Office covering the period from October 12 to December 14, 1917, giving the admission rates for regulars, national army and national guard contingents. It will be recalled that movements of troops to cantonment were planned for September 5 (687,000 men); September 19 (200,000 men) and October 3 (200,000 men). The initial figures therefore present a fair picture of the mobilization rate of venereal morbidity for our troops. In Table 1 they are placed beside the admission rates for the continental troops of the United States Army from 1905 to 1916. It seems to be regarded as characteristic of raw troops and recruits that they shall have a high rate (a relative increase is reported for the German Landsturm) (Lancet). The initial figure of 204.8 for the National Army is at once a confirmation of this point and a comment on the inefficiency of whatever prophylactic preparation might have been made for their reception. This figure is a little less than five times the reported British rate for February, 1916, 43.5 per 1,000, as given by the Financial Secretary of the War Office in response to a question in Parliament. The steady drop to 69 per 1,000, lower than any annual rate in the recent history of the United States Army, is a credit to the efficiency of the

agencies engaged in meeting this situation, and it is to be hoped that the later rise is only temporary. It should not be forgotten that weekly reports are subject to striking variations due to temporary conditions affecting the life and activity of troops, and that they are therefore not a fair measure of what a large-scale movement for the suppression of venereal disease in army or navy is accomplishing. From the trend of the other two curves in the diagram and the reports of the admission-rate for the Expeditionary Forces, (November 16, 81.1 and November 30, 75.8), it seems that on the whole the rate for our troops is if anything a little lower than during the past year and compares well with our best figures for peace times. Comparison of our lowest figures with those available for both our allies and our enemies, however, is not wholly encouraging, since our best nearly doubles the most recent British figures, is double the estimates for the expected rise in the German rate as predicted by Blaschko (*Lancet*), nearly double the recent Italian figures and is greatly in excess of the best foreign figures of peace times. That these best figures are among our enemies, that what fragmentary reports are available seem to credit us with the highest venereal morbidity of any of the major combatants, and that venereal disease is a more dangerous enemy than shrapnel, bombs and machine guns, gives us no cause for optimism or self-congratulation whatever.⁴

Chart 5 shows the relative proportions based on non-effective rate of syphilis, gonorrhea and chancroid reported for the continental troops of the United States during the period of highest morbidity preceding the application of modern prophylaxis, and the period immediately following. In the height of pre-prophylactic days, the ratio of syphilis to gonorrhea lay between 1:2.2 and 1:2.8. With the consistent application of prophylactic methods, this ratio changed to that of 1:1.6. The institution of prophylaxis, apparently, while causing a drop in the incidence of both diseases, has been relatively more efficacious against gonorrhea than against syphilis. The observation may throw light on the belief that the proportion of syphilis is actually increasing in the Austrian Army (*British Medical Journal Abstracts*). Chart 6 compares the admission rates for primary, secondary and late syphilis during the period of effective application of modern methods of diagnosis. Allowing for the steady drop in the ad-

⁴ The reports for cantonments on December 14 show a most gratifying drop in venereal admissions.—Regulars 69.7, National Guard 44.6, National Army 74.3.

mission rate for syphilis during this period, it is interesting to note the fact that the percentage of cases recognized as primary remains nearly constant, while the reduction is manifest in the cases which represent a tardy diagnosis, namely in the recognition of cases in the secondary stage. On the other hand, it should be realized that a proportion of 1 primary to 4 secondary cases recognized (1915) is a showing for which the British Navy is being severely criticised by its own medical officers (Dudding, Fildes and Dudding), on the ground that it represents an inefficient use of the dark field.

The table compiled by the Journal of the American Medical Association (Table 2) from the Surgeon General's reports of recent conditions in the army cantonments, illustrates in condensed form the high place held by the venereal diseases in the morbidity figures of the army (Table 6). The only rival thus far apparent is measles.

While the influence of prophylaxis is under consideration a further discussion of recent experience with it is in order. Broadly used, the term should include both educational and medical measures, and the war has materially assisted in emphasizing the importance of the former element. Educational measures as applied to the enlisted man include information as to the origin and course of venereal disease, its dangers, and the advantages of continence as the only sure protection from its risks. This information is conveyed by lectures from medical officers, and by brochures and leaflets of special confidential character. Emphasis has been placed by various writers on the importance of reiterating and repeating this instruction, and even incorporating it in the orders for the day (Mendel). The official circular of the French Army, prepared by the Academy (Cole) is brief, and exhorts the soldier to continence for the sake of his country and his own future, and then states that "if in a moment of weakness" he yields to temptation, he is to employ prophylaxis immediately. Lord Kitchener issued to British troops a special circular of appeal. It is reported that the German leaflet now gives explicit directions for the employment of personal prophylaxis. The British Army has apparently used the lecture to good advantage, and 750 talks had been given to 500,000 men up to March, 1916 (May). The very interesting summary of German conditions in the *Lancet* states that brochures and leaflets have been found to have much less value than was supposed, and that the most effective deterrent was the presentation before the men of an actual clinical example of a particularly bad case of venereal

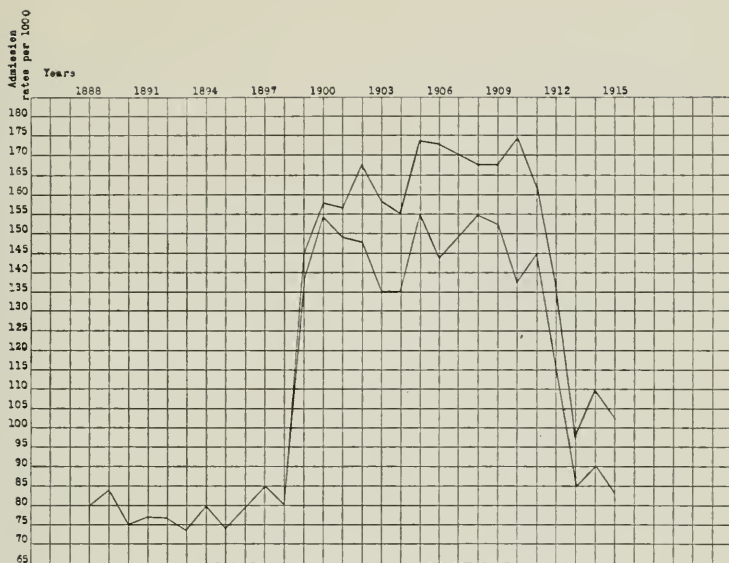


CHART 1.—Curves showing the incidence of venereal diseases in the United States Army from 1888 to 1915. The rapid decrease in venereal diseases for the years from 1910 to 1913, following systematic measures instituted by the government for their control, should be noted.

The lower line shows rates for enlisted force in the United States. The upper line shows rates for all enlisted forces both in the United States and abroad.

1888-98.—During this decade the Army was stationed throughout the United States, principally at small points. No compulsory physical inspection; no systematic propaganda to reduce venereal disease. The rates represent practically those patients unable to do duty. Cases not treated or in those doing duty were usually not recorded.

1898.—Spanish War Militia called into service.

1898-99.—Great change in the Army. Marked expansion. Old soldiers disappear. Volunteers come in. Young recruits sent to Cuba, Porto Rico, and the Philippines.

1899-01.—Philippine Insurrection, troops in Cuba, Porto Rico, and China.

1901-09.—High rates prevail in United States and abroad.

1909-11.—Principles of preventive medicine applied. Prophylaxis urged.

1911.—Syphilis increases. Wassermann test used in diagnosis.

1912.—Systematic measures. Fortnightly physical inspections and prophylaxis enforced by G. O., May 31. Pay Stopped G. O. 31.

1914-15.—Concentration on Mexican Border.

Lyster, W.: Venereal disease and the new Army. Jour. Am. Med. Assn., 1917, lxix, 1257-1259.

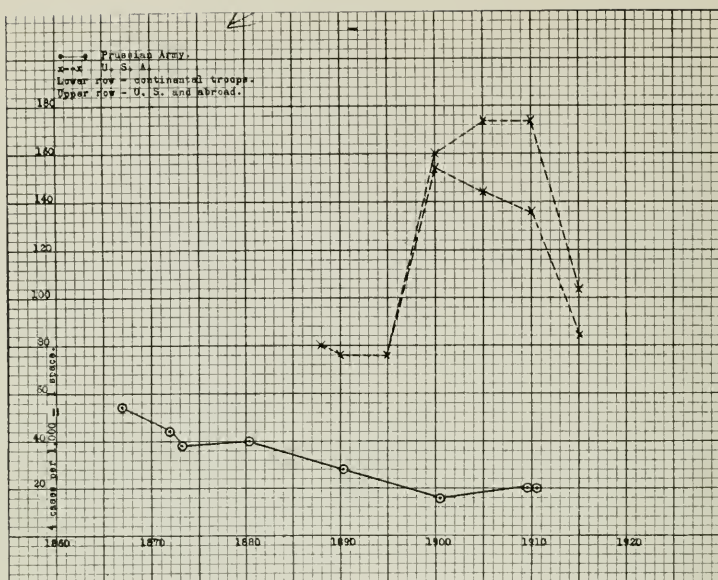


CHART 2.—Comparison of admission rates for venereal disease in the Prussian and United States Armies.

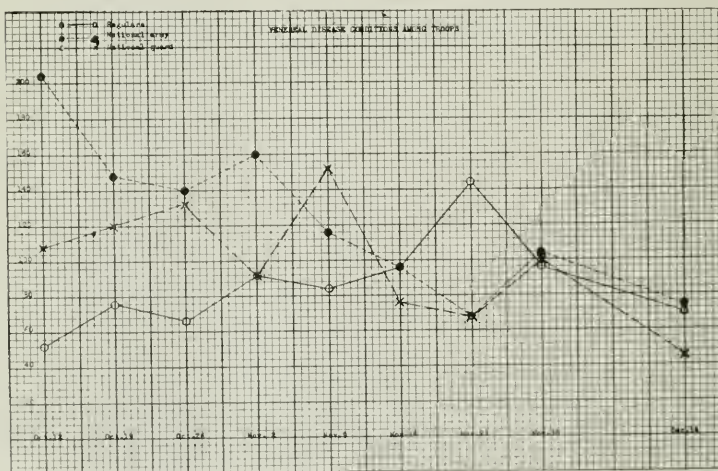


CHART 3.—Showing the admission rates for venereal disease of the United States Army (Regulars), the National Guard and the National Army during the present mobilization. (Figures reported in the Jour. Am. Med. Assn.)

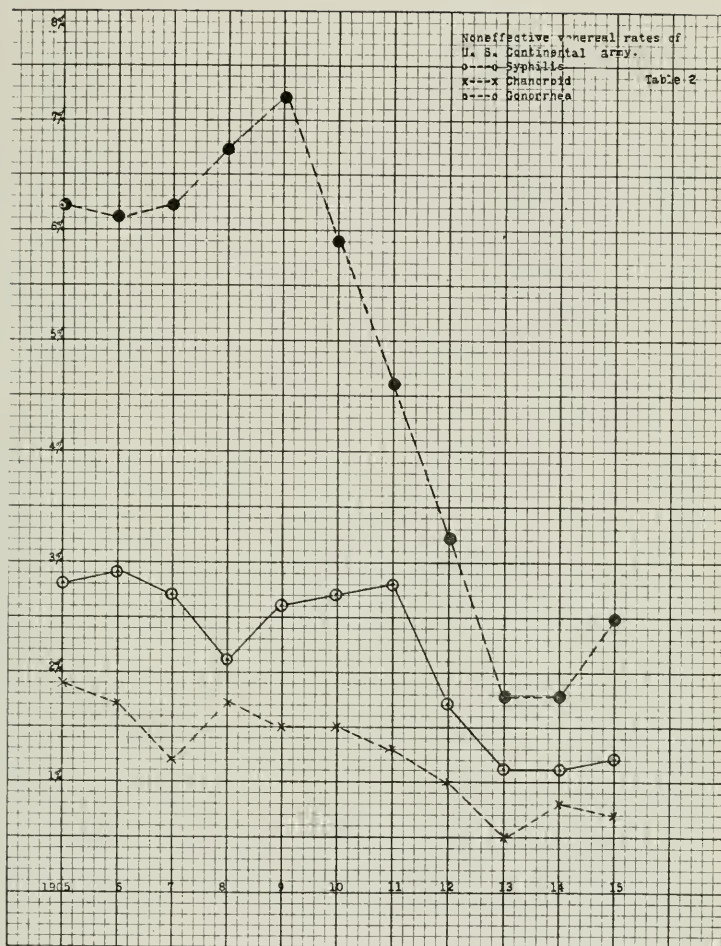


CHART 4.—Comparison based on non-effective rate, of the incidence of syphilis, gonorrhœa and chancroid, in the United States Army (Surgeon General's Reports). Showing the rapid drop in incidence under prophylaxis, most marked in the case of gonorrhœa.

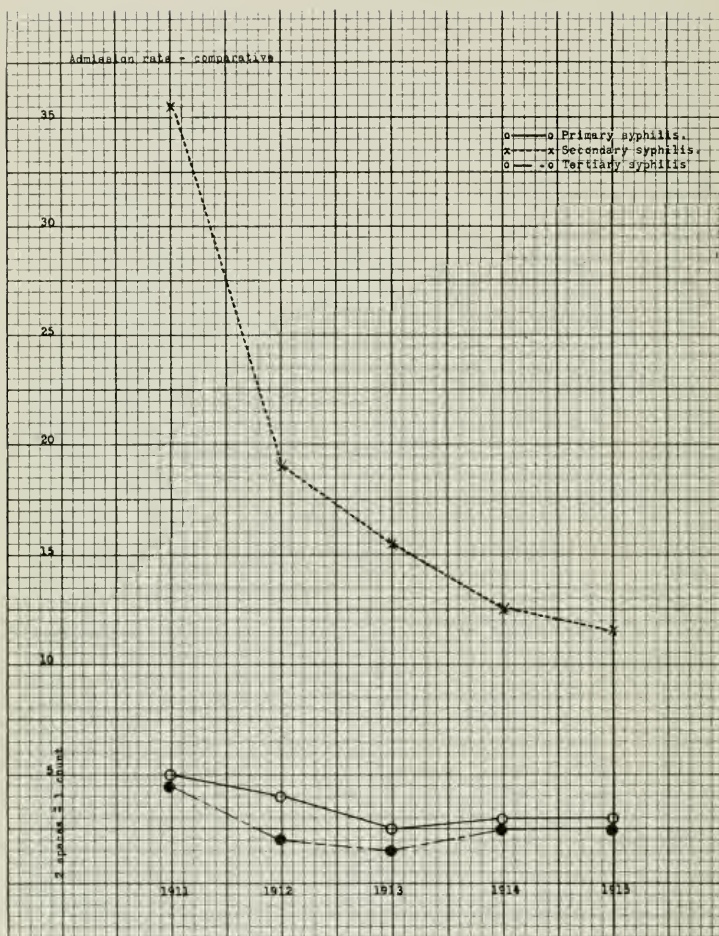


CHART 5.—Comparative admission rates for primary, secondary and late syphilis in the United States Army, based on the Surgeon General's Reports. The ratio of primary to secondary syphilis admitted is 1-7 in 1911, 1-4.75 in 1912, 1-6.2 in 1913, 1-4.83 in 1914 and 1-4.5 in 1915. The British Navy is being criticized for a ratio of 1-4.

infection. This I have myself found to be the case in my own work with syphilitics. Graphic, visual impressions such as those produced by a film like "Damaged Goods", recently reviewed by the War Department to determine its teaching value, and by the use of exhibits of the type shown by the American Social Hygiene Association and other organizations (from whom copies of the pictures may be obtained) have a special effectiveness, are being used at a number of cantonments, and are recommended by the official program. Munger's point based on his recent study of naval recruits, that boys between the ages of 17 and 21 take prophylactic lectures as a joke, and that only the "experienced" man can appreciate their seriousness, is worth considering and perhaps explains some of the Navy's difficulties. On the other hand there is undoubtedly a large personal element in the effectiveness of the teaching of certain officers. The express injunction contained in the Army manual against making prophylactic treatment a laughing matter, evidences the importance of this factor. To reconcile in the same talk, an exhortation to continence and instruction as to the value and use of prophylaxis, demands consummate artistry. Bombast, diffuse irrelevant sentiments and a sesquipedalian vocabulary have as little place in such instruction as the smirk and the veiled intimation "if you can't be good, be careful." The man with the compelling eye, who can use the ungloved vernacular and swing words like the hammer of Thor rather than the arms of a windmill, is the instrument for conveying educational prophylaxis. Riggs has produced some interesting figures from the Norfolk Naval Training Station to show what an enthusiastic medical officer can do to make prophylaxis effective. By this means alone he reduced the percentage of exposure in his men in five months from 126.7 per cent to 65.7 per cent.

Medical prophylaxis has now met with practically universal adoption in some form or other. In the army and navy of the United States it is punitive—that is, a man receives no pay for the time he loses on account of venereal disease. He is required to report for it, and if he fails to do so and is infected, he is arrested and subject to court martial and vigorous punishment. At the outset of the war, the German recommendation included punishment only for failure to seek prophylaxis. Great Britain has not formally adopted any attitude toward prophylaxis in her armies, owing to the influence of the governmental policy, but prophylactic treatment administered to the men is in use, and the Navy tolerates the prophylactic packet (Cole). Italy has at-

tached prophylaxis to her official houses of prostitution behind the firing lines. The prophylaxis station is in the entry of the house, and a special attendant administers treatment both before and after intercourse. This very bald way of conducting the matter certainly leaves nothing to squeamishness, and has an unpleasant resemblance to conditions during our own Mexican border mobilization as reported by Exner. Excellent results are claimed for the method, including a reduction of 40 per cent in the incidence of infection, which was needed in view of the preposterous antebellum rates of the Italian army as given by Schwiening. The Australasian medical service has placed a tent for prophylactic treatment at the entrance of every camp, and claims good results. That part of medical prophylaxis which has come under the fire of protest concerns the supplying of the man himself with a kit (called the K packet in the United States Army), containing prophylactic applications, usually in the form of a calomel ointment on the Metchnikoff formula (33 calomel, 10 lanolin, 57 petrolatum) and 10 per cent argyrol or 0.5 per cent protargol solution. Bauchman's modification consists (Tulledge) of calomel ointment with 1 per cent tricresol for both intraurethral and external use. The objections to this seemingly direct official invitation to sexual exposure have been most vigorously and convincingly expressed by Holcomb, and by Daniels, Secretary of the Navy. The personal prophylaxis has fallen into disfavor on account of its uncertainties as well, and this country is again aligned with sound Anglo-Saxon tradition rather than continental European practise in the discarding of it.

Station prophylaxis, in which treatment is administered to the exposed individual by a trained attendant has grown steadily in popularity, and is without doubt the most effective method available, provided the time factor can be controlled. It removes much of the uncertainty due to unintelligent employment. To a combination of delay in application with indifference on the part of the men, Holcomb attributes the poor success of prophylaxis in the United States Navy. Riggs, and Holcomb and Cather have shown that application of prophylaxis within eight hours keeps the percentage of failure within 1.5 per cent, and Riggs believes that within the first hour it is practically infallible. Statistical estimates of the efficiency of prophylaxis in European armies cannot be obtained, but Exner found that in a regiment of American regulars over a period of $2\frac{1}{2}$ years and in 10,000 treatments, the percentage of failure was 1.4 per cent. Riggs gives 1.88 per cent of 6,746 treatments. It is apparent therefore that though not in-

fallible, especially under the conditions of army life, medical prophylaxis is an indispensable weapon, and the nearer its application can be brought to the time of exposure the higher will be the efficiency of the army employing it from the military standpoint. The establishment of prophylaxis stations in cities adjacent to cantonments is being carried out as part of the American program.

Station prophylaxis varies somewhat in details in different armies. Bichloride solutions or a sublimate ointment may be employed instead of the Metchnikoff and 1/2000 to 1/4000 potassium permanganate solution as a urethral irrigation given from a height of 4 feet is endorsed by the British (May) as especially effective against gonorrhea. The Italians use both this and 1/200 protargol.

No consideration of venereal prophylaxis in the present war would be complete without an account of the social prophylaxis of venereal disease, which has sprung into well-deserved prominence. Although the conditions of warfare have always tended to lower the sex ethical code, it is conceded by all observers that the present war is peculiar in the strain which it puts on the character-foundation and mental state on which sexual morality rests. Monotony, loneliness, nostalgia, grinding physical and mental drudgery and the lumping together of every sort and condition of man from young fellows of high ideals and good breeding to toughs whose mouths never open except to belch obscenity, combine to start a leveling process which is completed by the shock and strain and horror of the trenches. The man who has just come out of the experience of modern war is for the time being reduced to primitive savagery, and signalizes his drop by the gratification of primitive lusts. His resistance is lowered exactly as to a disease, and, in appreciation of this fact, every belligerent nation has invoked the aid of social agencies to fill out the lacks of military life, to keep up the spirits, to provide encouragement for ideals, and to tide its men through periods of overstrain. Williams observed that the venereal morbidity of the British troops at Aldershot, where recreation facilities were abundant, was only one-third that of London, where there were no facilities. The Young Men's Christian Association and the Young Women's Christian Association in both this country and Great Britain are performing invaluable service in the maintenance of recreation and social centers and huts, keeping men in contact with reputable women through Hostess Houses and the "Take the Soldier Home to Dinner" movement, and main-

taining the home ties of men in whom forgetfulness would mean lapse. Even so seemingly simple a provision as the dispensing of liberal amounts of hot chocolate and non-alcoholic drinks behind the lines and in the trenches has attained to recognition as part of modern fighting technic. Theaters, movies, singers and entertainers, all have a place behind the lines. This elevation of means for the promotion of morale to a major position is one of the most distinctive movements of this war;—the recognition of the modern soldier as a man. The work of the agencies mentioned has been extending rapidly to other members of the Allies. At the outset of our own participation in the conflict, the Secretary of War placed in the hands of a Commission on Training Camp Activities (Martin), the direction of the work for American troops, this body to act in co-operation with the International Young Men's Christian Association and similar agencies.

The problem of prostitution has been partly discussed in relation to the present war. The calling of whole nations to service has altered the conditions of other wars in which there has been a relatively small fighting class, preyed upon by professional prostitutes. It has enormously enlarged the field for infection. The high proportion of married men among venereal patients has been noted by Scholtz, Tullidge and Wolff. These authors estimate that one-third of venereal patients are married men. Many women have been thrown on their own resources, and in parts of the war zone, as in Poland, absolutely reduced to prostitution as the only means of maintaining life (*Lancet*). Industrial readjustment at home has thrown the women into a camaraderie with men in the civil population which, in the general lowering of moral tone induced by the war, has soon led to alarming consequences. Women leading semi-clandestine sexual lives have been forced into promiscuous relations. The closing of the "Animierkneipen" in Berlin by police order, for example, left 700 women of easy virtue without occupation on twenty-four hours notice (*Lancet*). Repeated appeals from authorities such as Blaschko have called attention to the imperative need for industrial provision for women. The effect of these forces on the civil populations seems to have been to enormously increase the amount of clandestine relations within the war zone and it has been the impression of medical officers with whom I have talked that this great preponderance of clandestine over public prostitution persists in these regions in spite of the most vigorous repressive measures. These repressive measures include not permitting women who are not inspected prostitutes, to enter the

war zone without a military pass, and the wholesale arrests, imprisonments and deportations carried out by the Germans. On the other hand to judge from the low admission rates reported for British troops in the war zone, repressive measures must on the whole have some effect. The real danger is not in the fighting zone but behind the lines, and in the cities to which furloughed men resort. Carle and Jolivet have shown that infection behind the lines in France is from professionals and within the war zones from clandestines. Jolivet moreover, pointed out that of 100 men, 52 per cent were infected by registered and 48 per cent by non-registered prostitutes.

In undertaking to suppress prostitution about the cantonments of the American armies, the first act of the Secretary of War was to create a zone in which military authority would enforce complete prohibition of the use and sale of alcohol and suppression of prostitution. The arbitrary limit of five miles was set because of the impossibility of policing a larger zone. As a means of diminishing temptation and reducing the brazen display of vice, this is undoubtedly useful, although to be completely effective, a prohibited zone would have to be so wide that it would be impossible for a man by any means to get out of bounds and return before the expiration of his leave. In the place of this impractical measure, the Commission on Training Camp Activities has sought the co-operation of local organizations in all cities adjacent to camps, including women's clubs, civic leagues and public officers, urging them to clean up their territory, and where necessary using such compulsory measures as seemed appropriate. The clean-up of Newport, Rhode Island by the invoking of public sentiment, and the recent press report of the closing of all resorts in Rock Island, Illinois, are examples of the effective use of this type of procedure. Many cities, especially those which witnessed the scandals of the Mexican mobilization, have voluntarily adopted an abolition policy.

Reports of British methods in particular make special mention of the efficiency of women police in controlling the situation with reference to prostitution in industrial communities, in cities and in the neighborhood of army camps (May). So-called "camp mothers" have been proposed for the cantonments within reach of New York City. Their ability to handle a vice situation is undoubtedly greater than that of the ordinary police.

The Mexican mobilization taught this country the importance of the commanding military officer in the prophylaxis of venereal disease. The conditions reported by Exner are so at variance

with the traditions of conventional morality, and savor so much of the methods of the Italian system that it is small wonder that their disclosure has led to an absolute reversal of policy. He cites the experience of two camps in which prostitution was made difficult of access and alcoholism suppressed by a combination of stern insistence on the part of the commanding officer with favoring circumstances. In one of these camps in particular, the moral standards of the commander gave a tone of self-restraint and conscious pride in decency, to the entire camp. The prophylaxis rates for these two camps were 0.566 and 3.78 as compared with rates varying from 11.2 to 20.4 in camps where the indifference or actual approval of the military commander permitted regulated or unregulated prostitution to be carried on. In the Surgeon General's report for 1913 occur these words: "It is believed, therefore, that the time has come to hold the commanding officers responsible for excessive venereal rates occurring at their posts." As in the Spanish-American war, the Army Medical service still confronts the problem of the low rank of its officers, and their consequent inability to make the demands of health for troops under their charge felt against the opposition of an ignorant, bigoted or self-sufficient commander. Fortunately the agitation which this matter has received especially with reference to venereal disease in camps, and the very obvious drop in efficiency of a command in which *laissez faire* is the military policy, have led many commanding officers, influenced further by the uncompromising attitude of the Secretaries of War and of the Navy, to see the light.

The test of a program must be found in the study of its workings. The published plans for the prophylactic campaign of the Armies and the Navy of the United States embody as complete and well thought out a campaign as that of any nation with which our type of program is comparable. It would seem that we have yet to learn the lesson taught by Germany, of the absolute necessity for long-range preparations down to the smallest detail for the time when troops and convalescents will begin to return to this country. Both in the interest of the soldier and the civil population, a thorough-going follow-up system cannot be too promptly put into effect. Hecht has called attention to provisions of this kind in the Austrian Army, and Cottle of the United States Navy has devised a system. Major Clark has just reported on an excellent follow-up system in use in one of the cantonments (Camp Lee). It is too early yet to read results, but the high venereal rates prevailing during mobilization would

seem to need investigation. The extension of the campaign for the education of recruits in the pre-mobilization stage, before they start for cantonment seems a worth-while suggestion. Every registrant for the draft in this country should, before he is called, have had placed in his hands by his exemption-board or medical examiner, exact information as to the nature and dangers of venereal disease, of the obligatory character of prophylaxis, of the penalties for neglect and concealment and of the uncompromising attitude of the Government on the subject. If possible, no man should be assured of discharge at the close of the war who has acquired a venereal disease just before or during his service. It will remain for further reports on the venereal morbidity to show whether there is a flaw in our system or whether its formal planning can indeed be translated into successful action.

Before taking up the closing section on the treatment of venereal disease in the present war, a number of interesting miscellaneous and unclassifiable points might be mentioned.

The occasions of most serious danger to troops from venereal disease to judge from Continental experience seem to be:

1. The period of mobilization and training.
2. Occasions when troops are moved with delays of some hours from place to place, either at home or behind the lines of communication.
3. While on furlough.
4. While encamped or billeted in cities or villages, especially when billeted to private houses.
5. While convalescent from wounds in hospitals, outside the zone of military activity.

The experiences of our present mobilization are similar to the rise in our venereal morbidity which accompanied the Vera Cruz expedition, to the experience of Germany in the early months of the Franco-Prussian war (Finger) with that of Austria in this war as vividly described by Finger in Vienna and Klausner in Prague, and so on. Klausner noted a second wave of venereal infection in his clinic with the return of convalescents from the front. One of the most tragic features of these home-comings, to which Gaucher and Bizard as well as Klausner call attention is the marital infection of wives, many of them ($\frac{2}{3}$ of 222 women) over thirty, whose symptoms come on a few days after the visit of the husband.

Figures accredited by the British Medical Journal to Moldovan at a conference of Austrian medical officers in Lemberg, showed that 5 per cent of troops with venereal disease were infected at the front, 20 per cent in lines of communication, and 75 per cent outside the sphere of the army.

German attention to detail has formulated the principles which should be observed in the protection of troops in transport. According to Finger, no alcoholic beverages are served by station restaurants, and the men even on a long stop are not allowed to leave the station platform. Where troops must be quartered in transit in or near towns, the leave of the men is so restricted or countermanded that the risk of exposure is reduced. Counter attractions are being furnished in the form of clubs and reading rooms as in the American program.

The prevalence of extragenital lesions under war conditions seem to be a field for difference in statistics. Tullidge reports 60 per cent of the primary lesions seen in 1,000 men as extragenital and in every conceivable situation. Cole states that he has personal information to the effect that they were common on the Mexican border. On the other hand they are rated as the rarest type of lesions by MacGrigor in a British venereal service and by Jolivet in a French hospital. Malingering in the acquiring of a venereal infection, especially gonorrhea, seems according to Tullidge, to have run riot in the Austrian army before the institution of heavy penalties, although it is apparently not so conspicuous elsewhere. Malingering in delaying recovery from gonorrhea is reported (Grajewski).

Another interesting point to which my attention has been called by medical officers returning from the front is the apparent increase of venereal morbidity proportionately to the rate of pay. The Canadian and Australian troops are said to have been apparently for this reason conspicuous marks for the attention of loose women. The English soldier with his shilling a day and the Frenchman with a few sous make less attractive objects. This point certainly deserves close study with a view to applying a remedy if one can be found. The high pay of American troops will subject them at once to such an influence if it exists. Removal of the profitableness of the male customer would go far to suppress the traffic.

Conditions in the civil population with respect to increase in the venereal morbidity to be expected as a result of the war are of great interest but unfortunately few figures seem to be avail-

able, and these are largely French, and based on indirect evidence. Gaucher and Bizard found that before the war in a series of 3,000 cases at the Saint Louis Hospital the proportion of early syphilis was 10 per cent. After the first sixteen months of the war the proportion had risen to 16.6 per cent and in the last eight months, up to December, 1916, to 25 per cent of the cases seen. Moldovan noted in the Austrian army a definite increase in the proportion of syphilis to other infections. Klausner noted the marked drop in morbidity that followed the removal of men to the front after mobilization, and the second wave which followed furloughs and convalescent leave, but gives no figures. It is a fundamental principle that men acquiring venereal infections should be given no leave of any kind until no longer infectious, but the results show that the principle is either difficult of application or more honored in the breach than the observance.

In general it may be said that the war has contributed little or nothing new to either the diagnosis or the treatment of venereal disease—certainly nothing to compare with the advances in war surgery. The vastness of the scale of operations is the chief feature of interest. Under war conditions the care of medical casualties of this type is a burden to medical officers, and they cannot be expected to bring to it the enthusiasm, the time or the special training for originality. The scarcity of specially trained men and the extraordinary ignorance of the average medical man on the subject of venereal disease has been a matter for widespread comment all over the world, Germany and France have special provisions included in their official programs for the remedying of these conditions now and after the war, both by the formation of special clinics for instruction of physicians and by the inclusion of more thorough teaching in medical school curricula. The few contributions which do appear, based on the clinical experience of large venereal services, often exhibit a singular naivete, much to be regretted both as evidence of priceless opportunity being lost, and of serious import for the future of the cases involved.

The treatment of venereal disease in war, must, it is true, draw a compromise between returning men promptly to the front, and securing as nearly as possible a curative effect on their disease. Yet a policy too opportunistic will entail results serious out of all proportion to the temporary saving of time and manpower, on account of the well-known predisposition of syphilis and gonorrhea to contagious relapse. Diagnosis and treatment

therefore, should attain a maximum of promptness and vigor. Procedures must be as intensive as the endurance of the patient will permit, and to reach this maximum intensity they must be supervised by experts.

The sudden creation of a vast problem in the treatment of venereal disease has necessitated in several countries, the creation of special administrative machinery in addition to the regular army medical facilities. In France for example, the Under Secretary of State for the Medical Service of the Army created special services of urology and of dermatology and syphilis, with a special venereal center for each of the 21 divisions in the front. To these special hospitals all cases arising both in the line and at the base hospitals are sent. Cases must not even be held at a regimental hospital for the identification of a suspicious lesion. Each center includes hospital and consultation service, a dental service and a laboratory. Apparently the consultation service at the venereal center co-operates in the care of civilians as well as troops. The work of such a center is described by Pautrier.

The British Army, according to a recent account carries on the treatment of venereal disease as part of its general hospital system. Four hospitals devoted entirely to this work are in operation. The British General Hospital No. 39 is described by Hirschman as consisting of 3,000 beds, 400 of them for officers. Eleven thousand, five hundred cases have been treated in this hospital since January, 1915, and 89,000 injections of salvarsan and neosalvarsan given. The enormous scale of such operations is apparent.

Little information is obtainable as to the details of the German administrative system from the standpoint of treatment. At the beginning of the war, Neisser in opposition to the majority of German syphilographers urged that syphilitics receive treatment in the line by an ambulatory system comparable to that of a dispensary, while acute gonorrhea was treated in the rear. His ideas did not meet with general acceptance and the policy of Germany now is to hospitalize the acute stages of all venereal disease, as in the case of England and France, returning men to the front as rapidly as possible. The dearth of experts in this field has been felt in Germany as in other countries, and has resulted especially in the needless sending of men back from the front to special hospitals for venereal disease for treatment with such banal dermatoses as pityriasis rosea and herpes progenitalis (Lancet).

Some months after the entry of the United States into the war, and on the eve of mobilization, steps were taken to place the organization of a special venereal service on a separate basis. A committee of civilian specialists⁵ co-operated with the Surgeon General and the Chief of the Division of Infectious Diseases in the planning and organization of the medical aspects of this work. The United States Public Health Service is expected to organize civilian clinical co-operation (Martin). The medical committee has published a manual of treatment, suggesting therein a standard practice and outlining a general program of organization and work. As in the French Army, two services, a genito-urinary to care for gonorrhea and its complications, and a dermato-syphilologic, are provided. The hospital facilities are included in the general base or cantonment hospital of at least 1,000 beds, no separate hospital being provided, although the services have their own wards. These two divisions work in harmony with the regimental infirmaries and with all agents charged with the prophylaxis of venereal disease. The devising of a system of record, of arrangements for following infected cases and for the disposal of men after the war have not been touched on by this committee in their manual except in a general way, and are apparently left to the initiative of individual officers such as Major Clark of Camp Lee. This committee will no doubt perfect such arrangements before the close of the war. At the outset, the committee has made a vigorous effort to improve on European methods by enlisting the services of specialists rather than general men for the work of the cantonments.

With reference to diagnostic technic, the venereal services of the present war are in the main employing to good effect the dark-field examination of the untreated lesion, and the Wassermann follow-up when the organisms cannot be demonstrated. British practice, in diagnosis as in treatment, is evidently not uniform and at times none too advanced. One specialist (sic) in charge of a hospital has reverted to the archaic clinical criteria for the diagnosis of primary lesions, eschewing the dark-field in routine work. The British naval medical service has had criticism within its own ranks for its failure to diagnose more than one case of syphilis in four (26.5 per cent) until the appearance of secondaries (Dudding, Fildes and Dudding). Of 671 men

⁵ Wm. Allen Pusey, Chicago, Francis R. Hagner, Washington, Grover W. Wende, Buffalo, Sigmund Pollitzer, New York, Henry H. Morton, New York.

with venereal sores, 63.4 per cent were diagnosed at once as syphilitic by dark-field, and only 13.9 per cent of those remaining were subsequently shown to be syphilitic by the Wassermann and follow-up. The vital importance of adequate laboratory facilities and expert assistance for this sort of work is appreciated by every syphilographer. The problem of an army or navy venereal service is to recognize early infections, and shortage or inefficiency in this direction is disastrous.

The importance of the regular inspection of troops for venereal lesions has been brought out by the war, especially where the men are of a less intelligent type. To the lack of this inspection, in part, Lyster ascribed the low admission figures of the United States Army in the early '90's. The venereal expert should invariably accompany the regimental medical inspector. Tullidge showed that in the 2,200 Austrian troops whose cases he studied, 60 per cent of the infected men identified had not yet made application for treatment. Every syphilographer can cite numerous instances in which men untrained in dermatology overlook or misinterpret characteristically syphilitic cutaneous manifestations. Of the many types of cutaneous, and general types of lesions, Gougerot points out that the lesions most often misinterpreted are gummatous adenitis, gummatous lesions operated as carcinomata, condylomata diagnosed as hemorrhoids, chronic arthritides, obscure fever, and eighth nerve accidents of syphilitic origin. The diagnosis of syphilis as a complication of wounds and trauma should be suspected in all cases of delayed or unsatisfactory healing. Ring-like gummatous infiltrations about the margins of wounds are illustrated by Gougerot.

Very wide diversity seems to exist in the methods employed by way of treatment, to accomplish that most desired of military ends, the return of an infected man to the front. The extent that this lack of uniformity in methods of treatment and ideals reached in the United States Army was pointed out by Vedder. He stated that in thousands of records, in hardly two cases under Wassermann study was the same treatment given. Sojourn in military hospitals is intended to accomplish two things, to carry the patient through the infectious stage in which he is a danger to his fellows, and to carry him past the risk of the most immediate complications. It is to the credit of the United States that the committee having charge of this phase of the work at present urges in its manual something more than these purely opportunistic ideals and has made a strong move for intelligent standardization. A typical example of the penny-wise and pound-foolish

policy is found in the treatment methods of the British navy which are, as far as syphilis is concerned, absurdly inefficient, and sufficient explanation of the inability to get negative Wassermann findings. It must be conceded, however, that the standard proposed for our own army as recently as 1913, (Bull. S. G. Office, No. 3, 1913), based on one of Gennerich's earlier schemes, is quite as inadequate. Judged by the best modern standards of intensive treatment, much of the work being done at the front now is reasonably good, and the only question is the one which applies to all the ultra-modern technic, as to how permanent the effects may be.

Salvarsan, as a German product, disappeared from the markets of the Allies when war was declared, and the manufacture of substitutes was at once begun under license from the various home and colonial governments. The war has therefore cost Germany a most lucrative monopoly, and taught the world at large, and, it is to be hoped, this country especially, a lesson as to the danger of monopolistic control of agents necessary to public health. After a period of uncertain results, kharsivan, the British substitute, galyl (1119 M) of Mouneyrat, and novarsenobenzol of Billon may, with the American product arsenobenzol (Schamberg) and the Canadian diarsenol, and neodiarsenol be said to have definitely established their safety and efficiency. Preparations of the type of neosalvarsan are in great demand because of the rapidity with which they can be administered. Where, as in a British hospital (Grajewski) 120 injections are given in eighty minutes the need for speed and exceptional technical accomplishment is apparent. Carle reports from his service that three injections are given each patient in twenty-five days. This is obviously below modern standards. The British are much more thorough and seem to average eight injections per patient (89,000 to 11,000 patients in Hospital No. 39). Twelve injections are given according to Grajewski, at Rouen. It will be recalled by way of comparison that Gennerich, whose results have been exceptional, at the Marine Hospital at Wik in Germany, before the war, gave, in early secondary cases, from two to four courses of six injections each. Hirschman states that the British use intramuscular more than intravenous technic. The complications of salvarsan administration seems to be few (dermatitis and jaundice 152 cases in 89,000 injections, for example) and the deaths on the same service, about one in 8,000 injections. Deaths in the United States Army were estimated by Nichols at one in 5,000 injections.

Mercurialization seems to be prevailingly intramuscular, the biniodide, 20-25 injections (Carle), grey oil, etc. Mouth prophylaxis seems to be effective.

The Wassermann is used in the main merely to determine the status of the case, and not necessarily to determine the amount of treatment, since men free from symptoms are sent back to the trenches regardless of the findings (Hirschman).

Nothing conspicuously new seems to have developed in the management of gonorrhea. The permanganate irrigation seems to have an unflinching popularity. Vaccines are liberally used by the British in complications. The standard for discharge from the Rouen service (Grajewski) is three negative smears at five day intervals, and the patient loses all leave for a year.

From such information as is obtainable, then, it appears that modern methods of diagnosis and treatment of syphilis in particular, are receiving as much of a trial as the demands of the military situation permit. Hard-pressed for time and over-run with patients, it is not to be expected that many remarkable individual studies will be made by the men engaged in this work. The value of the records of these enormous services is problematic, and will depend in large measure on the perfection of the system which, it is to be hoped, will in every army and country follow the once-infected soldier throughout his service and throughout his life. No more colossal experiment to prove or disprove the possibility of our golden hope, the abortive cure, could be imagined.

SUMMARY.

The imperative necessity for action on the problem of venereal disease has carried Europe for the time being well ahead of this country in movements designed to deal with this problem.

The Anglo-Saxon programs of England and West Australia are conservative for the trend of the times and confined to curative rather than to prophylactic effort.

The programs of other European countries, under the strain of military necessity, and guided by a tradition of regulated prostitution, have adopted radical prophylactic programs, in addition to the basic measures relating to treatment.

Germany has progressed farther than any other country in the extension of medical prophylaxis to army and civil population. Italy and France have carried officialized prostitution, following the precedent of Japan, into their army systems.

In preparation for the venereal problems incident to the close of the war, Germany's preparation seems to lead the world.

The United States, long backward in the movement, has now adopted a strong military with a weak or non-existent civil program. Civil effort is still local and spasmodic in its manifestations, though encouraging.

A timely combination of organized sentiment, official perspicacity and principle, and an unsavory Mexican border experience has committed us to a policy of repression of prostitution, combined with all forms of personal, educational and social prophylaxis.

The standing of the United States Army in the matter of venereal morbidity has not always been the best.

We experienced the expected wave of mobilization morbidity, the National Army rate reaching the proportions of five times the present British rate. Extraordinary improvement has recently occurred.

Our medical service has been only fairly efficient in the early recognition of syphilis.

Educational prophylaxis is occupying an increasingly important place in the efforts of all countries.

Medical prophylaxis by the station method, with attention to the time factor, is one of the most efficient instruments in existence for the control of venereal infection. With only average conditions, the failures range between 1 and 2 per cent of all cases treated.

Social prophylaxis, based on the growing recognition of the fact that the soldier is a human being, has assumed a prominence never before attained.

The familiar influences are increasing prostitution and irregular sexual relations on a large scale all over the world. The chief danger to soldiers is from professionals behind the lines, and clandestines in the war zones.

Inspected prostitution seems to have no advantage over uninspected.

Women are especially effective police in this field.

The commanding officer is an important factor in the control of a venereal situation.

This country should utilize every means to educate each man called to the colors before he is mobilized, and should at once take steps to imitate the preparations of Germany for the close of the war and the disposal of infected men, including their sur-

veillance by civilian agencies and clinics. At these points our program is weakest.

Miscellaneous points drawn from European experience include special risks to enlisted men, troop transport, convalescent infections, relation of pay to temptation, increase of syphilis in the general population, etc.

There have been no strikingly new contributions to the diagnosis and treatment of venereal disease. Military necessity dominates this field also, and treatment in general has to draw a compromise between curative ideals and the refitting of the patient for further service.

Standardization of treatment, a much to be desired end, has been undertaken for the United States Army.

British Army results probably represent the optimum now being attained outside of Germany, on whose methods no information is obtainable.

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EDITORIAL NOTE.

A. S. WARTHIN.

The statistics of the incidence of venereal disease in the American Army, as shown by the chart given in Dr. Stokes' article, are frequently quoted to show the favorable results obtained by the introduction of medical prophylaxis. Other factors, however, must be considered before the decline in the incidence of these diseases since 1909 can be ascribed entirely to the effects of prophylaxis. The withdrawal of the army from the tropics, its reduction in size, the small number of new recruits, and educational factors as well must be considered in the analysis of this diminished venereal incidence in the army between 1909 and 1915. As soon as the troops were again brought into service on the border with new recruits the incidence began to rise in 1913. The statement is frequently heard and also sometimes published that the experience of the American Navy with medical prophylaxis has been similarly successful in reducing the incidence of venereal disease in the Navy. As a matter of fact the statistics for the Navy, as shown by the charts published in Holcomb's article, show that since 1909, during the eight years in which medical prophylaxis has been carried out in the Navy, venereal infection has increased instead of diminishing. Under the system of medical prophylaxis the admission rate for gonor-

rhea has almost doubled, that for chancroid has more than doubled, while that for syphilis is but little higher. It is also very probable that the Navy statistics are more reliable than those from the army. See Tables 1, 2, and 3. There is, however, a still better way of estimating the effects of prophylaxis, and that is by considering the damage rate, as per Tables 4, 5 and 6. Table 4 for gonorrhoea shows that when prophylaxis went into effect in 1909 the damage rate per 10,000 increased to 16.6 and has not been lower than 15.05 since that time. The damage rate from gonorrhoea cannot, therefore, be said to show improvement under prophylaxis. As far as chancroid is concerned the damage rate for the four years preceding 1909 is lower than for any year since. Table 6 shows that the damage rate for syphilis since 1911 is somewhat lower than in preceding years. It is possible that the use of salvarsan may be responsible for this apparent improvement rate in the damage rate of syphilis. Taking it all in all the damage rate from venereal disease in the Navy has been raised rather than lowered.

Most significant are the efforts made in certain states, as California and Michigan, to attack the venereal problem from the standpoint of communicable diseases dangerous to the public health. A new epoch has been opened by the health measures placing the venereal diseases in the list of reportable diseases. The War has brought about what might otherwise have taken generations of effort.

That some of the citizens of the State of Michigan are awake to the significance of the situation is shown by two meetings held in Detroit last spring, at which the State Social Hygiene Association was revived, and by the called meeting held in Jackson in September. At this meeting a definite program was adopted. The following set of resolutions previously adopted by a similar meeting in California was unanimously adopted, and a permanent Committee appointed to go before the Governor with the request that a State Commission for the Control of Venereal Disease be appointed, and that active measures for the prevention of venereal infection at Camp Custer be carried out:

PROGRAM FOR THE PREVENTION OF VENEREAL DISEASES IN THE STATE OF MICHIGAN.

1. Prostitution is to be suppressed vigorously and continuously, through the enforcement of the State laws, and the issuance of certificates of health to prostitutes for use in soliciting is not to be included in this program.

2. Prostitutes brought to the attention of the police or health authorities are to be examined; and all persons, male or female, capable of spreading venereal disease are to be isolated, under the provisions of the public health act, or local ordinance, and treated at public expense as long as there is danger in the opinion of the health officer, of their exposing others.

3. Under no circumstances are infected prostitutes to be "floated" into other communities, and if they are known to go from one community to another, the health officials of the places of destination are to be notified at once.

4. The State law requiring the report of syphilis and gonococcus infections by physicians', office numbers, is to be enforced to the letter, and in addition physicians are to be urged to obtain, and furnish to the local health officers, the names of the persons who are suspected of disseminating infection. The local health officers are, therefore, to investigate and supervise and isolate infectious cases according to the circumstances.

5. To provide and encourage the instruction of young men and women in the advantages of a clean life and the dangers from venereal disease.

6. To provide adequate opportunities for expert diagnosis, treatment, and advice for infected persons financially unable to secure proper attention for themselves, and to encourage the continuance of treatment until the patient is cured, or at least becomes non-infectious.

7. To provide free laboratory tests for syphilis and gonococcus infections for physicians, and encourage greater use of the tests for these diseases at the laboratory of the Bureau of Communicable Diseases of the State Board of Health.

The committee appointed at Jackson met the Governor and the War Board, and presented the situation to them. A committee of five was appointed by the Governor to make recommendations as to the method of proceeding with the preventive work. At a meeting of the committee of five held in Lansing the following recommendations were submitted:

1. The sources of infection to be located in every possible way.

By securing the co-operation of the military medical authorities in the reporting of cases from whom soldiers have acquired infection.

The appointment by the State Board of Health of a special medical inspector to be stationed at Battle Creek, and the detailing of inspectors to other points if necessary.

Co-operation with the local health authorities of various communities in the State.

Suggestions to the cities of Battle Creek and Kalamazoo of the desirability of securing the services of full-time Health Officers.

Furnishing, by the State, of free laboratory tests for venereal diseases.

2. Segregation of infected persons.

Infected soldiers to be segregated in camp, by military authority.

Infected women to be segregated in detention hospitals or by house quarantine, if necessary.

Hospital facilities at Detroit and Ann Arbor being now available, the Commission recommends the use of these hospitals until further arrangements can be made.

3. The treatment of infected persons.

Soldiers to be treated in camp by the military medical authorities.

Infected cases in the civil population to be cared for in the segregation hospitals above mentioned and in free clinics to be established at various points in the State.

4. The supervision of cured or arrested cases.

By paid social workers in each of the several communities near the encampment.

5. By enlargement of the protected zone.

The military authorities to be requested to extend the zones under authority of the Act of May 18, 1917.

6. By a campaign of education.

In the military camps, thorough co-operation with the Medical Corps of the army.

In communities throughout the State, under the auspices of the State Board of Health.

The above program, it is realized, is not complete. It offers, however, a definite step in the direction of lessening the terrible menace which is now confronting the nation and it further will give the State of Michigan the distinction of being a leader in this field of public health protection.

STATE BOARD OF HEALTH GIVEN SUPERVISION.

These recommendations were accepted by the Governor and the State Board of Health was directed to proceed with the preventive measures suggested. Co-operation of the State Board of Health with the military authorities at Camp Custer has already been secured and the machinery of the State Health Office has already been set in action along the lines outlined in the recommendations of the committee. Blanks for the reporting of gonorrhoea and syphilis have already been distributed, and the response from the physicians of the state is more encouraging than was anticipated. The blank used in reporting these diseases is shown here:

WAR MEASURE

PHYSICIAN'S REPORT OF A CASE OF GONORRHOEA OR SYPHILIS.

(This report must be mailed to the State Board of Health as soon as the physician has knowledge of a case of gonorrhoea or syphilis not to his knowledge previously reported.)

TO THE STATE BOARD OF HEALTH:

There has come to my knowledge a case of.....
(Gonorrhoea or Syphilis)
in the of
(Township, city or village) (Name of township, city or village)
County of, State of Michigan.
Name, initials or office number of the person infected.....
Age Sex Single
(Male or female)
Married Widowed

GONORRHOEA.

When contracted.....Source of infection.....
.....
Is patient so guarded as not to be able to infect others.....

SYPHILIS.

When contracted.....Source of infection.....
.....
Stage: Primary (), Secondary (), Tertiary () Lesions present.....
Is patient so guarded as not to be able to infect others.....
(Signed) M. D.

Date 191.... Post Office.....

In many instances it will be a decided advantage to the public health if the physician will report not only the information asked for above, but a complete history of the case, and thus give opportunity to institute such restrictive measures as are indicated.

Complete and prompt reports of OPTHALMIA NEONATORUM must be made.

The State Board of Health has placed a special Health Officer at Battle Creek for the protection of Camp Custer. Since November 18, 1917, this office has apprehended and placed under treatment the following number of venereal disease-carriers:

*"44 women in the Hermann Kiefer Hospital, Detroit.
6 women in the Jackson Hospital.*

12 women in the Devore Hospital, Grand Rapids.

2 women in Harper Hospital, Detroit.

5 women in their own homes.

20 men in the State Board of Health Hospital, Battle Creek.

January 26, 1918.

W. F. ENGLISH, Director."

For all cases placed in hospitals the State War Board is paying \$15.00 per week, the total cost of board and treatment. In the local State Board of Health Hospital at Battle Creek the cost per patient is very much less.

As a final comment upon this question, the Great War will be well worth while if through it society is brought to realize the significance of the venereal diseases and to put them upon the basis of dangerous communicable diseases.

Warthin, A. S.: Bulletin "Public Health" of Michigan State Board of Health, Oct.-Nov., 1917.

VENEREAL DISEASES IN THE NAVY.

TABLE I.

GONORRHOEA.

ADMISSION RATE		ADMISSION RATE	
YEAR	PER CENTUM	YEAR	PER CENTUM
1880	3.02	1899	2.48
1881	3.08	1900	2.20
1882	3.28	1900	2.29
1883	3.59	1902	2.46
1884	3.71	1903	2.77
1885	4.02	1904	3.72
1886	4.23	1905	5.04
1887	4.11	1906	6.20
1888	3.47	1907	4.90
1889	2.81	1908	5.69
1890	2.43	1909	Prophylaxis 10.25
1891	2.46	1910	begun 10.39
1892	2.79	1911	9.21
1893	2.51	1912	8.72
1894	4.00	1913	8.06
1895	2.50	1914	8.49
1896	2.13	1915	8.79
1897	2.05	1916	8.26
1898	2.09		

TABLE II.
CHANCROID.

ADMISSION RATE		ADMISSION RATE	
YEAR	PER CENTUM	YEAR	PER CENTUM
1880	.76	1899	1.08
1881	1.21	1900	.90
1882	1.35	1901	.80
1883	1.32	1902	.90
1884	2.00	1903	1.06
1885	1.96	1904	1.33
1886	2.18	1905	1.30
1887	1.73	1906	1.72
1888	2.29	1907	1.19
1889	1.05	1908	1.25
1890	1.29	1909 Prophylaxis	2.75
1891	.86	1910 begun	3.37
1892	1.00	1911	3.14
1893	1.40	1912	3.50
1894	1.66	1913	2.81
1895	1.15	1914	4.33
1896	.92	1915	3.23
1897	.86	1916	3.50
1898	.91		

TABLE III.
SYPHILIS.

ADMISSION RATE		ADMISSION RATE	
YEAR	PER CENTUM	YEAR	PER CENTUM
1880	5.39	1899	1.95
1881	4.90	1900	1.95
1882	5.86	1901	2.03
1883	4.60	1902	1.93
1884	4.00	1903	2.19
1885	3.68	1904	2.16
1886	3.90	1905	2.37
1887	3.25	1906	2.69
1888	3.85	1907	1.90
1889	3.66	1908	1.89
1890	3.07	1909 Prophylaxis	2.58
1891	2.45	1910 begun	2.25
1892	2.09	1911	2.71
1893	2.03	1912	2.30
1894	3.05	1913	2.19
1895	1.81	1914	1.98
1896	1.68	1915	2.13
1897	1.57	1916	2.22
1898	1.59		

TABLE IV.
DAMAGE RATE FOR GONORRHOEA (URETHRA).

YEAR	AVERAGE COMPLEMENT	ADMISSIONS	D.	DIS.	SICK DAYS	DAMAGE PER 10,000	DAMAGE
1880	10233	309	..	22	5932	27.20	26.5
1881	11118	343	..	3	5436	16.39	14.7
1882	10631	350	..	3	5279	15.96	15.01
1883	9874	354	..	3	5287	15.98	16.1
1884	10948	407	..	6	7507	23.50	21.4
1885	9191	370	..	4	5810	17.91	19.4
1886	9188	389	..	..	5618	15.39	16.7
1887	9618	396	..	..	4641	12.71	13.2
1888	9955	348	..	3	4109	12.72	12.6
1889	11219	316	..	1	5203	19.25	17.1
1890	11768	286	..	2	4665	13.87	11.7
1891	11501	284	..	3	5066	15.37	13.3
1892	11775	329	..	2	5080	14.87	11.7
1893	12109	304	..	3	4717	14.52	11.9
1894	12520	501	..	4	7103	21.45	17.1
1895	13191	330	..	..	6032	16.52	12.5
1896	14196	303	..	1	5210	14.73	10.3
1897	15734	323	..	2	6131	17.79	11.3
1898	23986	503	..	28	10735	43.40	18.1
1899	20819	517	..	9	11586	36.24	17.4
1900	23756	525	..	9	10794	33.99	14.3
1901	26873	617	..	2	10816	30.63	11.3
1902	31240	771	1	6	10360	31.88	10.2
1903	37248	1032	..	1	11643	32.39	8.6
1904	40555	1512	..	15	14953	48.35	11.8
1905	41313	2085	..	11	15137	46.96	11.3
1906	42529	2640	..	7	17958	52.69	12.3
1907	46336	2274	..	8	13912	42.11	9.08
1908	52913	3015	..	14	18229	56.80	10.7
1909	57172	5861	..	33	28801	95.40	16.6
1910	58340	6064	..	17	31836	95.72	16.4
1911	61399	5660	..	26	33867	105.80	17.2
1912	61897	5403	..	26	35140	109.00	17.6
1913	65926	5320	..	27	33204	104.46	15.8
1914	67141	5703	..	10	36218	104.22	15.5
1915	68075	5085	..	11	35404	102.49	15.05
1916	69294	5731	..	7	43357	121.96	17.6

TABLE V.
DAMAGE RATE FOR CHANCROID.

YEAR	AVERAGE COMPLEMENT	ADMISSIONS	D.	DIS.	SICK DAYS	DAMAGE PER 10,000	DAMAGE PER 10,000
1880	10235	78	..	2	1302	4.55	4.4
1881	11118	135	..	1	2602	7.62	6.8
1882	10631	144	..	2	2819	8.72	8.2
1883	9874	131	..	..	3051	8.35	8.3
1884	10948	219	..	1	4833	13.70	15.1
1885	9191	181	..	2	3614	10.90	11.8
1886	9188	201	..	5	4095	13.71	14.9
1887	9618	167	..	..	2878	7.88	8.1
1888	9955	228	..	..	2968	8.10	8.1
1889	11219	118	..	..	2714	7.43	6.6
1890	11768	152	..	..	3416	9.35	7.9
1891	11501	100	..	..	1939	5.31	4.6
1892	11775	118	..	..	2046	5.59	4.7
1893	12109	170	..	1	2913	8.47	6.9
1894	12520	208	..	1	3817	10.94	8.7
1895	13191	152	..	1	3401	9.81	7.4
1896	14196	131	..	..	3481	9.51	6.6
1897	15734	136	..	1	2754	8.04	5.1
1898	23986	219	..	5	5305	17.03	7.1
1899	20819	226	..	3	5747	17.24	8.2
1900	23756	214	..	1	5189	14.67	6.1
1901	26873	217	..	2	5592	16.31	6.0
1902	31240	284	..	..	5788	15.85	5.0
1903	37248	396	..	..	7644	20.94	5.6
1904	40555	542	..	4	7661	22.93	5.6
1905	41313	538	..	2	5469	15.98	3.8
1906	42529	733	..	..	6562	17.97	4.2
1907	46336	534	..	..	6311	17.29	3.7
1908	52913	665	..	..	6570	17.95	3.3
1909	57172	1573	..	1	9539	26.63	4.6
1910	58340	1968	..	1	9975	27.82	4.7
1911	61339	1929	..	..	12547	34.37	5.5
1912	61897	2169	..	..	12634	34.51	5.5
1913	65926	1855	..	..	11464	31.40	4.6
1914	67141	2908	..	1	14749	40.90	6.0
1915	68075	2200	..	..	10521	28.82	4.2
1916	69294	2436	..	1	12816	35.51	5.1

TABLE VI.
DAMAGE RATE FOR SYPHILIS.

YEAR	AVERAGE COMPLEMENT	ADMISSIONS	D.	DIS.	SICK DAYS	DAMAGE PER 10,000
1880	10235	552	1	37	15527	61.42
1881	11118	545	1	18	14548	49.35
1882	10631	623	..	22	13898	49.07
1883	9874	454	1	28	11432	45.81
1884	10948	438	1	24	12817	47.51
1885	9191	339	..	19	8392	32.49
1886	9188	359	..	21	9530	36.60
1887	9618	313	..	11	8546	28.91
1888	9955	384	1	13	9416	32.72
1889	11219	411	1	18	12196	42.90
1890	11768	362	..	8	10095	31.65
1891	11501	282	..	19	9489	35.49
1892	11775	247	1	15	8629	31.57
1893	12109	246	1	14	7739	28.69
1894	12520	383	1	21	10635	40.13
1895	13191	239	..	13	11965	39.28
1896	14196	239	1	21	10239	38.95
1897	15734	248	1	29	11289	40.92
1898	23986	383	1	78	11720	71.60
1899	20819	406	2	45	15425	65.75
1900	23756	465	1	78	21791	99.03
1901	26873	546	2	73	21656	96.83
1902	31240	606	..	69	26794	107.89
1903	27248	816	..	132	34112	159.44
1904	40555	880	..	125	32389	150.98
1905	41313	981	5	92	39632	157.06
1906	42529	1147	..	91	41248	158.48
1907	46336	881	1	105	32656	140.62
1908	52913	1001	2	116	36645	159.11
1909	57172	1476	5	166	49647	221.49
1910	58340	1316	3	114	47971	189.92
1911	61399	1668	2	84	66660	225.62
1912	61897	1426	..	75	56841	192.80
1913	65926	1447	4	70	62630	208.58
1914	67141	1332	2	49	53016	170.72
1915	68075	1454	3	60	65682	211.45
1916	69294	1542	5	62	67814	218.78

INFECTIVE JAUNDICE.

(*Spirochaetosis icterohaemorrhagica*.)

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Infective jaundice, known also as Weil's disease, epidemic catarrhal jaundice, etc., has come into prominence during the last three years as a war infection. First reference to it appears in "De internis affectionibus" attributed to Hippocrates and is described as the fourth kind of jaundice. The first undoubted reference, however, is that of Cleghorn, (1745), who describes an epidemic in Minorca. Other epidemics, 1793, 1794, were mentioned by Hirsch. D. Larrey, (1800), at the siege of Cairo drew especial attention to the infectiousness of a disease characterized by icterus and haemorrhage. Budd, 1845; Ozanam, 1849; Monnewt, 1859; Carville, 1859; Worms, 1865; Genouville, Blachey, Hirard, Trousseau, Laveran, Londouzy, 1882; Lancereau, 1882; Mathieu, 1886; Weil, 1886, have recognized the clinical entity and described cases. It is possible that the etiological factor was not the same in all cases as the descriptions vary somewhat among themselves. However, the injustice of attaching Weil's name to the disease following his description of four cases is evident and especially so, in view of the fact that Mathieu, a few months before Weil's publication, had called attention to the fact that the clinical picture deserved the title of infectious jaundice.

Extensive epidemics have been described,—one in Rotterdam, 1863, involved 300 persons, others especially noticeable occurred in England in 1894, 1901, 1911. During the Civil War in the United States, there were 22,569 cases with 161 deaths in the Federal Army of 2,218,559 men. The Boer War had 5,648 cases with unknown mortality. Among the civilian population and troops about Paris in 1870, '71, and '72, it was common, 799 cases out of 33,000 Bavarian troops stationed at Prais having been reported. Epidemics of greater or less extent have been noted in all parts of the world,—British Isles, France, Germany, Austria, Russia, Norway, Sweden, Denmark, Holland, Switzerland, Italy, Greece, Egypt, Smyrna, India, Japan, China, South Africa, North America, Island of Martinique in the West Indies, Cuba, Australia, New South Wales. In North America, small outbreaks have occurred in middle west, southern states, Toronto, etc. An extensive outbreak in 1899-1900 occurred in

North Carolina. In certain parts of Japan the disease is both endemic and epidemic.

During the present war, this disease has been reported on the western front among French troops by Martin and Pettit, Costa and Trosier, etc.; among the British troops, by Stokes and Ryle, Dawson and Hume, etc.; among the Italian troops, by Monti, etc., among the German troops, by Uhlenhuth and Fromme, Hubener and Reiter, etc., and by MacKenzie among the Canadian troops in Salonica.

While the disease is known especially among troops in the field, it has long been noted that the cases in civil life affect particularly sewer workers, miners, butchers, rice planters, and inmates of barracks, poor houses, etc.

GENERAL CLINICAL PICTURE.

The clinical picture can be grouped according to Inada into three stages, febril, icteric, and convalescent.

The febril stage, which constitutes the first six or seven days of the illness, is commonly ushered in by chills and fever together with a feeling of faintness or giddiness. This is so abrupt that as a rule the patient is able to date the onset from some simple duty he was performing at the time. Characteristic symptoms of vomiting, headache, pain in the back and limbs develop early. The patient complains of great muscular weakness, general soreness all over the body as if he had been badly bruised. This may be so marked that the patient is loath to move, even to turn in bed. The pains are usually restricted to the muscles of the limbs and the patient complains of unsteadiness and inability to stand. Pain in the eyes and vague abdominal pains are encountered. Marked hyperemia of conjunctiva bulbi is seen. The accompanying fever varies from 103° to 105°F . The urine contains albumin.

The second or icteric stage lasts from the sixth or seventh to the twelfth or thirteenth day. The symptoms are less severe, icterus appears, frequently a haemorrhagic diathesis is seen, general muscular weakness and often nervous symptoms which started in the febril stage are encountered. The urine shows albumin and bile pigments.

In the third or convalescent stage, the icterus disappears, one notices anaemia and emaciation. An "after fever" occurs in 30-40% of cases.

Death occurs most frequently during the last of the second stage.

Alimentary System.—The tongue is excessively dry, brown in color, often fissured. Anorexia is the rule. The lips show sordes. In 42% of cases, the herpes labialis become haemorrhagic. Vomiting is an almost constant symptom of the first stage. The vomitus may be bilious and occasionally streaked with blood possibly swallowed from the naso-pharynx. Constipation is usually extreme and has to be relieved by enemata. A few cases show initial diarrhoea. The stools are usually somewhat bile-stained, occasionally clay-colored. Several cases are on record where haemorrhagic diarrhoea proved fatal but this is exceptional. Abdominal pains are always general. Usually, there is unlocalized tenderness somewhat more marked in the upper abdomen.

The liver may extend three finger-breadths below the right costal margin. In the majority of cases it is not palpable.

The spleen is rarely palpable.

Circulatory System.—The pulse rate is usually slow even when no jaundice is seen. With a fever of 104° to 105° , the pulse may be only 100 per minute. Rhythm is usually good. Blood pressure never falls as in the enteric group of diseases. Systolic pressure ranges about 120 mm. of mercury. Very exceptionally, in severe cases, the rate is rapid.

Respiratory System.—As a rule, no respiratory complications are noted. In all severe cases, however, there is evidence of an acute bronchitis. In 25% a blood-tinged sputum bright or rusty is noted. Epistaxis occurs in about 20%. In severe cases, the rate of respiration may increase to 28 or 30 per minute and resemble the breathing in uraemia.

Urinary System.—A small per cent of cases have difficulty in urinating and in a few, there may be complete anuria, possibly of central nervous system origin. The amount of urine during the early stages is usually diminished. In jaundice cases, the urine contains a large amount of bile which may give it a dark porter color. Bile continues to be excreted until the end of the fourth or fifth week. Occasionally, in the absence of jaundice, bile may be detected in the urine. Albuminuria is a constant feature of the pyrexial stage. In severe cases, the quantity of albumin excreted may be considerable while in mild cases, there may be merely a trace. This albuminuria may continue for a long time after the jaundice has disappeared and the patient is well on the road to recovery. Casts, hyaline and granular, together with red blood cells, are seen in centrifuged specimens. In severe cases, acetone

may be demonstrated in the urine, possibly a result of the high fever and vomiting. All cases show a greater or less degree of urea retention depending upon the extent of renal involvement.

Nervous System.—Frontal headaches with pain behind the eyeballs, generalized pains and stiffness are constant symptoms. Antipyretics have little effect. The muscular pains in back and legs are very severe. General weakness and great prostration in the early stages are characteristic. In fatal cases, twitching and convulsions may precede the coma resulting in death. Torpor and even a rambling delirium may be encountered.

Lymphatic System.—The lymph nodes of the cervical, axillary, and inguinal region are enlarged, especially the latter two.

The Skin.—Jaundice does not develop as a rule until the fourth or fifth day of the illness. The color varies from lemon yellow to a deep orange tint but seldom approaches the greenish color of obstructive jaundice. In some cases, jaundice never appears and the diagnosis is made from the laboratory findings together with the general clinical picture. By the ninth or tenth day, the icterus has reached its height and begins to fade. This takes but a few days. Haemorrhagic herpes labialis occurs in 45% of cases and is frequently of wide extent, covering at times the chin and upper part of the neck. The herpes may form a black confluent eruption about the mouth and invade the nares. Petechial haemorrhages in some cases are found distributed all over the trunk. A slight pruritus may be encountered.

Fever.—Fever is high at the onset, 103° - 105° and even above. This initial fever drops slowly by lysis so that by the end of two weeks the temperature may be normal. A period of slightly subnormal temperature may set in lasting one to three days. This may be followed by complete recovery or a relapse of the fever without any other symptom. This secondary rise in temperature which occurs usually on the fourteenth or fifteenth day, lasts from four to twenty days. Between 28 and 40% of cases show this secondary fever. It is absent in fatal cases.

DIFFERENTIAL DIAGNOSIS.

Infective jaundice is characterized by high pyrexia, prostration and conjunctival congestion with absence of any local symptoms. This excludes catarrhal jaundice, gallstones and cholecystitis. Jaundice due to paratyphoid and typhoid infections is excluded by blood cultures, the agglutination curve, and the fact

that in these cases the jaundice develops as a rule about the end of the second week. Exceptionally, however, this enteric type of jaundice may appear as early as in cases of true infective jaundice. Here the atropine test (Dawson and Hume), introduced by Capt. H. F. Marris, R. A. M. C., in the diagnosis of typhoid fever, may help. One-thirtieth of a grain of atropine sulphate is given hypodermically and the increase in pulse noted every minute for the next hour. If the heart rate increases only ten beats or less, the evidence is that the patient is suffering from an enteric form of jaundice. The test must be made when the heart rate is not over 85 per minute. The most frequent mistakes in diagnosis are pneumonia, pulmonary tuberculosis and trench fever. Between trench fever and non-icteric infective jaundice, it is almost impossible to differentiate in the early stages. Anticipating a little, we may say that the demonstration of the spirochaeta *icterohaemorrhagica* either in the blood or urine by direct examination or by G. P. inoculation is necessary for absolute diagnosis. This will be discussed later.

PROGNOSIS.

On the European front, the mortality does not exceed 6% and is probably nearer 3%. In Japan, the death rate is about 30% (Inada and Ido). An epidemic in Alexandria reported by Valassopoulos had 32% mortality. Sandwith reports an epidemic with 10 to 60% mortality in Smyrna.

Attention should be called to the fact that, as has been shown by Merklen, Salomon and Neveu, Costa and Troisier and others, the disease may present quite a different picture from the one mentioned above. For example, certain cases of war nephritis are due to the same etiologic factor as infective jaundice. Again certain cases of meningitis have been shown to be due to this same agent (Costa and Troisier). Attention has already been called to the cases of non-icteric infective jaundice.

ETIOLOGY.

It is now definitely established that the causative agent in injective jaundice is the spirochaeta *icterohaemorrhagica*. Other agents have been named—notably typhoid and paratyphoid bacilli. These, while able to cause a catarrhal jaundice, do not play any part in Weil's disease.

The spirochaeta *icterohaemorrhagica* was discovered in 1914 by Inada and Ido, two Japanese workers. It was discovered in-

dependently a year later by Uhlenhuth and Fromme in Germany. The Japanese workers succeeded in infecting guinea pigs with the blood of early cases of the disease and subsequently finding the organism in the animal. Inada and Ido's work and subsequent work by others has shown that the human blood contains the spirochete during the first four to six days. Subsequent to this, the organisms disappear from the blood stream and are never found in it after the tenth to twelfth day of sickness. In the guinea pig, they seem to localize in the liver and kidney especially. This holds also for man, but in man the organism is very hard to demonstrate at autopsy either by staining or by the use of dark field. The assumption is that the immune bodies developing in the body destroy the spirochetes in the blood and those in the liver and kidney. Certainly in man, this disintegration of the organism is very complete, while in the guinea pig, they find on autopsy that the liver and kidneys are swarming with the spirochetes.

Inada and Ido were the first to obtain cultural growths. The method originally used is the same as that used by Noguchi in the growth of *pallida*, that is, a medium containing a fresh piece of organ. (Guinea pig liver was used here.) Reiter, Martin and Pettit, and others have used rabbit serum diluted four to five times with physiologic salt solution or Ringer's solution, citrated blood diluted with physiologic salt solution, etc., in all cases covering the media with paraffin. Growths have been obtained on solid media. The organisms grow forming a slight cloudiness one to two cm. below the paraffin layer. The optimum temperature is 22 to 25 degrees C. Growth commences in three to seven days.

As to the organism itself, it is a slender, very motile spirochete with an average length of 6 to 9 μ , width, .25 μ . At times it may attain a length of 12 to 20 μ . It is wavy, undulating, often seen in the shape of a letter S with a hook-like turn at one end. Flagella have been demonstrated at either end, (Martin, Pettit, and Vaudremer). The body of the organism is formed of tightly twisted spirals so that in a space of 4 to 5 μ there may be as many as 10 to 12 coils. This gives a beaded appearance to the spirochete under the dark field illumination. The extreme activity of the organism is a very noticeable feature. It passes through a Berkefeld No. 5 filter.

When subject to the action of 10% saponin, the spirochetes in question are not affected, differing in this respect markedly from other spirochetes.

Among laboratory animals we find that the guinea pig is the most susceptible to the disease, which is nearly always fatal. Rabbits but rarely succumb to the infection, mice and white rats frequently. It is fatal to dogs.

Among guinea pigs, death follows from five to eight days after an I. P. injection with lesions similar to those in man except that (1) there is usually somewhat more hemorrhage especially in the lungs, and (2) the spirochetes are more numerous in the liver of a G. P.

LABORATORY DIAGNOSIS.

The early diagnosis of infective jaundice is impossible from the clinical picture and following the discovery of the infective agent, laboratory findings have been resorted to. Attempts to find the organism in the blood stream during the early stages meet with but little success. The organisms are few in number, seen only with difficulty in a dark field microscope, and disappear from the blood entirely by the tenth to twelfth day. An attempt to find them by staining or the dark field takes but little time and should be tried. Presence of the spirochete in the blood is best demonstrated by injection of 2 or 3 cc. of blood intraperitoneally into guinea pigs. The animals inoculated usually succumb in six to ten days. Occasionally, however, the period of incubation is much longer, twenty-five to thirty days. At autopsy, the organism can be demonstrated in the liver and elsewhere (Levaditi's older method), but even before death the appearance of icterus, etc., furnishes definite indications. Blood or tissue smears may be stained the same as the urine sediment—see below.

As pointed out by the Japanese workers, the spirochetes are eliminated chiefly by the kidneys. Demonstration of the organism in the urine is then of great value. Inada has shown that the spirochetes are to be found in 52% of cases by the tenth day, and may be demonstrated occasionally as early as the second or third day. By the twentieth to twenty-fifth day, all cases show spirochetes in the urine, which may be present even as late as the sixty-fifth day, but are usually gone by the fourth or fifth week. To demonstrate their presence, a portion of the urine, 50 cc., is centrifuged. The deposit is washed in distilled water and re-centrifuged. Smears are made of the deposit. These may be stained by any one of several methods, Harrison's

collargol method, India ink method, 2% aqueous solution of Congo red as recommended by Benians, bieosin method of Tribondear and Dubriul or best of all by Fontana's method or one of its modifications (Nankivell and Sundell). The Giemsa method gives good results.

The modified Fontana method consists of (1) washing smears two minutes in a mixture of 8% formol and 1% glacial acetic acid; (2) washing in absolute alcohol one minute, drying; (3) wash in distilled water; (4) mordanting in a hot solution of 5% tannic acid and 1% carbolic acid for two minutes; (5) washing in water; (6) pouring over the slide a stream of 2% silver nitrate (containing enough ammonia to give it a slight opalescence) until a nice brown color is obtained; (7) washing in water, drying. Diagnosis by smears alone is always open to error, especially in untrained hands. In case of negative findings, repeated examination must be made and as control careful examination for the enteric group in doubtful cases. Inoculation of a guinea pig gives the best answer. Recognition of the organism in the feces is difficult and best carried out by guinea pig inoculation.

Attempts by Costa and Troisier, Pettit and others to use complement fixation for diagnosis show that it is impossible to differentiate serum of infective jaundice from syphilitic serum.

The presence of specific immune bodies has been demonstrated by Inada and others in patients as early as the eighth day of the disease.

As a result of the laboratory method of diagnosis, it has been possible to demonstrate that the spirochete *icterohemorrhagica* may localize in various parts of the body other than in the liver and kidney, notably in the central nervous system. A number of cases have been reported of cerebrospinal infection due to this organism (Costa and Trosier, and others). The spinal fluid in all these cases is highly infectious and the organism easily demonstrated by dark field microscope or staining.

Not less important has been the demonstrations that some cases of so-called War Nephritis proved to be nothing more than the localization of the spirochete *icterohemorrhagica* in the kidney with or without the usual liver complication. In these cases, the blood pressure is very low, severe anuria may be present which, when complete, indicates a grave outcome. The blood urea may reach as high as 6.50 and in fatal cases always increases up to death. The vomiting so often seen in the usual

form of the disease is very likely influenced by this uremic poisoning which may also be responsible for the condition of mental confusion frequently seen.

AUTOPSY FINDINGS.

The skin usually shows marked jaundice, multiple petechial hemorrhages may be present in the skin, in the peritoneum, pericardium, and pleura. There may be hemorrhage in the heart muscle and under the endocardium. Small hemorrhages in the lung substance are constant features. This is especially seen in guinea pigs. The liver is usually normal in size, color and consistency, while the kidneys are enlarged, swollen, bile-stained, and show multiple hemorrhages. Intestine and bile passages are normal. Axillary and inguinal lymph glands are enlarged and surrounded by laked blood.

MICROSCOPIC FINDINGS.

The liver presents microscopically a diffuse granular degeneration hardly of significant extent. Exudates of polymorphonuclear leucocytes in the interstitial tissue and small bile ducts are almost suggestive of small abscesses. Bile pigment is seen in the liver cells without lobular distribution. Bile pigment is also seen in the small blood vessels and distended intralobular bile capillaries. Congestion is marked.

The kidney shows acute lesions, granular degeneration of the tubular epithelium especially in the proximal convoluted and ascending limbs of Henle's loop. All tubules are involved, many obliterated. Diffuse exudates of polymorphonuclear leucocytes in small numbers are seen. Small hemorrhages in poorly defined areas involving several tubules occur. The blood is for the most part in the tubules, widely distending them, a condition especially marked in the distal convoluted portions.

Lymph glands are found surrounded by laked blood and are somewhat hyperplastic.

Autopsies of the first stage (up to the sixth or seventh day) show spirochetes by Levaditi's method in the liver, adrenals, kidneys, involuntary muscle, heart muscle, thymus, testicle, epididymis, etc. They are intercellular. As the disease progresses, the spirochete disappears first from the liver, and those remaining become intracellular. During the third stage, they are to be found in the kidney and heart muscle only. All forms are intracellular except those in the kidney tubules.

TRANSMISSION.

The method of transmission in infective jaundice has already been indicated, that is, through body excretions. As we have noted above, the urine of a patient even when well on the road to recovery may show a large number of spirochetes. Feces also contain the organism. These facts with the occurrence of an occasional carrier indicate one method of possible contagion.

Not less important is the fact brought out by the Japanese workers and verified on the western battle front that the disease is endemic in ordinary sewer rats, house rats, field rats, etc. (40% of the brown rats in Japan are infected). Noguchi, also Jobling and Eggstein, have found the organism in American rats. The excreta of these rodents have been shown to be infectious. Dogs have been known to contract and spread the infection.

Due to the fact that this organism grows readily at 22° to 23°C. and is not easily killed, it becomes evident that water pollution is a serious source of infection. Acid soils have been shown to have a destructive action on the organisms in contrast to neutral or alkaline soil.

As to the method of entrance of the spirochetes into the body, the alimentary tract offers a very convenient route. This, however, does not seem to be the usual method of infection. It has been demonstrated that the organism can easily penetrate the unbroken skin. In experiments on guinea pigs, this occurs in 100% of cases when placed on a shaven surface. One case of laboratory infection is reported contracted by this method, (Uhlenhuth and Fromme). The period of incubation is six to eight days.

When we recall the occurrence of infective jaundice among rice field workers, miners, etc., this method of infection seems very important. In Japan, they have been able to show that the mine workers infected were those who worked in the damp and wet parts of the mine.

On the French front, epidemics have been traced back to a given sector of the line and then even back to a particular trench, the only one on that section in which the men were forced to stand in water. The possibility of food contamination due to dirty hands, drinking water, pollution, etc., remains. Records show a few cases of infective jaundice resulting from rat bites, both experimental and accidental, and one case is related of a German officer who took care of his pet dog while it was sick with infective jaundice. The dog licked its master's hand fre-

quently and as a result, the officer contracted and died of the disease. This rat-borne nature of the disease explains its frequency among butchers.

PROPHYLAXIS.

The methods of prophylaxis are already indicated. The drainage of wet places in which men are compelled to stand becomes imperative. This prophylaxis has yielded excellent results in the hands of the Japanese. In certain mines where infective jaundice has been known for years, it has been completely stamped out by the simple procedure of draining. Similar results on a limited scale have been obtained on the Western front where however the necessities of war make it difficult to meet the required conditions.

Use of disinfectants, care of excreta, etc., is self-evident.

Serum prophylaxis can be considered under two heads—active and passive. The passive immunity is of so short duration that its use as a prophylactic measure is useless. As a method of treatment, it will be spoken of later. Active immunity has been especially studied by the Japanese with excellent results. They have been able to produce a very good immunity in guinea pigs by the use of cultures killed by .5% carbolic acid. In horses, they have produced a very active immune serum. In the case of man, they have, by the use of two or three injections from 6 to 8 days apart of this .5% phenol-killed culture, been able to obtain serum giving an active Pfeiffer reaction.

TREATMENT.

One naturally turns to salvarsan treatment when spirochetes are involved but unfortunately in this disease, the results are not satisfactory. The organisms in the tissue are not killed. The condition of the liver is also aggravated by the use of arsenic compounds.

By far the best treatment and the most promising at the present time is the serum treatment. It has been possible to obtain, as the Japanese workers have shown, a horse serum 1/100 cc. of which will protect a 200 gm. guinea pig against 1 cc. of a culture containing 15 to 20 spirochetes per field.

Injected in the early stages of the disease, especially before the appearance of the jaundice, it has been possible to prevent this icterus and destroy all organisms in the blood. The treatment yields very favorable results on the course of the disease.

The Pasteur Institute has also prepared an immune serum.

The serum treatment gives good results in this case of spirochetosis apparently because of the fact that unlike other types this organism does not become serum fast, relapses never occurring.

SUMMARY.

Infective jaundice is caused by the spirochete icterohemorrhagica. It localizes especially in the liver and kidney. It is excreted in urine and feces.

The organism can penetrate the unbroken skin. Its principal mode of infection seems to be penetration of the skin of the legs of men compelled to stand in contaminated water.

The disease is endemic among rats which act as a constant source of infection.

Prophylaxis is indicated by the mode of infection.

Vaccine prophylaxis has been tried with apparent success.

Serum treatment yields very satisfactory results.

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CEREBRO-SPINAL FEVER.

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Cerebro-spinal fever as a disease entity was first clearly recognized by Vieusseux in the Geneva epidemic of 1805.* This was a general epidemic of the people of the city and vicinity affecting all ranks equally.

The most thorough account of the History of Epidemics of Cerebro-spinal fever is that given by Hirsch, whose account is here followed, and from whom the historical references were obtained.

After 1805, until 1830 there were sporadic epidemics in Europe and the United States especially. Following the Geneva outbreak, the disease attacked the garrison at Grenoble in March and April, 1814, and also the garrison at Paris. From this time until 1830 there were outbreaks in Metz, in the province of Genoa, at Vesoul and at Dorsten in Westphalia, possibly the epidemic at Wiesentheid in Lower Franconia and that at Sunderland in 1830 reported by Scott. The confusion in diagnosis and tendency of the disease to simulate other infectious diseases, a fact still noticeable in the modern literature, was present especially in the early epidemics. Thus in the United States, it was spoken of as "sinking typhus", and "spotted fever" and "typhus exanthematicus". There was a widespread epidemic in New England from 1814-1816, and during the same time in a less intense form in widely scattered areas of the United States and Canada. After two localized outbreaks in Middletown, Connecticut in 1823, and at Trumbull, Ohio, in 1828, the United States was free until 1842. Perhaps the most interesting period in the history of cerebro-spinal fever is that which corresponds to Hirsch's second period from 1837-1850. During this time widespread epidemics broke out in France, Italy, Algiers, the United States, and Denmark. This period is especially marked by its prevalence among the military population. The observation of these epidemics, noting the conditions under which they occurred, and the manner in which

* Unless we accept vague references, such as the biblical reference cited by Horder, "He went out to his father to the reapers, And he said unto his father, my head, my head. . . . And when he had taken him and brought him to his mother he sat on her knees until noon and then died."

the disease was carried from place to place by the movements of soldiers was of great service in the early understanding of cerebro-spinal fever. Cases appeared in 1837 simultaneously at Bayonne and the department of the Landes, and the districts of Foix and Narbonne. From here epidemics were widely disseminated (see map). The disease at Bayonne was "strictly limited to the garrison". It attacked simultaneously the civil population of small towns along the Adour, and solely the garrisons at Bordeaux and La Rochelle. It reappeared again in the Garrison at

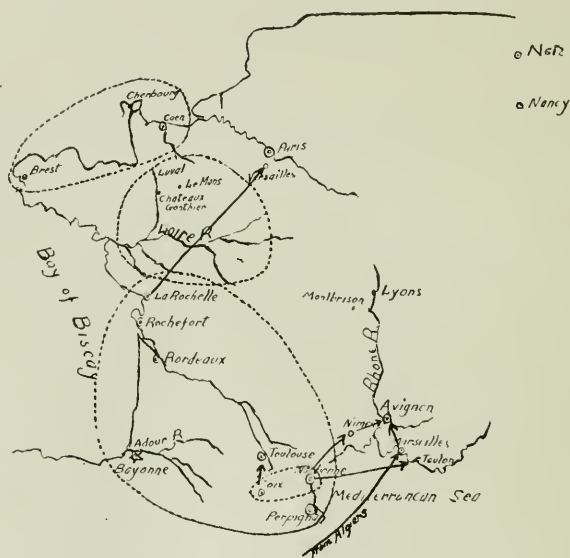


FIG. I.

Bordeaux in 1839. The transmission of the disease by military movements was shown in the epidemic in 1838 at Rochefort where it broke out first in isolated cases in a regiment coming from Landes, which had had an epidemic among the soldiery in 1837, and later in the civil and military population of the prison. Hirsch lays great stress on this transmission by companies of soldiers and special credit is due to him for his observations which were made long before the causative organism was known. He says in part: "At the beginning of 1839 the epidemic appeared at Versailles, in the first instance among those very soldiers, who had come from the Landes, (Foix and Narbonne) to Rochefort

and had been transferred thence in 1838 to Versailles; it quickly attained the dimensions of an epidemic which was strictly within the limits of the garrison as were also the occasional cases of the following year and the second epidemic in the year 1848".

The whole history of this period is a lesson in military dissemination. In Laval it occurred in the garrison in 1840, later spreading to the town. Among the soldiers at Le Mans and Chateau-Gonthier, who had come from Laval it appeared again in 1840. Throughout the basin of the Loire after this until 1842, there were outbreaks at Poitiers, Tours, Rambouillet, at Blais, Joigny, and Ancerris and Nantes. These epidemics started among the soldiery and spread to the townspeople later. Another focus was started in northwest France at Brest among the marines in barracks (1840), the troops at Caen, and the garrison of Cherbourg. A center in northeast France sprang up at Metz (1839) and Strassburg spreading into the vicinity as detachments of troops moved about. At Nancy in 1841 all the cases but one were among the military. From Foix and Narbonne in South France in 1837 it appeared at Hers and Toulouse in 1838, and in the garrisons at Nimes and Toulon. In the winter of 1839 meningitis sprang up in the garrison at Avignon. During this time it was epidemic at Perfignan and Montbrison. In the winter of 1841 it appeared at Marseilles among soldiers who had returned from Algiers. After 1842 it was still seen occasionally in the garrison towns of France. In the following years repeated outbreaks occurred in France, Italy, Algiers, United States, and Denmark with the always recurring factor of military dissemination being prominent. A gradually spreading epidemic in Algiers in (1840) finally 1846-1847 spread to the Arab population in remote parts of the country but the first cases were in the garrison. A widespread outbreak occurred in southern Italy (1839-1845). There was an outbreak in Denmark from 1845-1848 called *hjernfeber* (brain-fever) which reached to Iceland. In the period from 1842-1850 there were repeated widespread epidemics in the United States in widely separated parts of the country not connected with military operations. These outbreaks extended from Tennessee and Alabama throughout the south-central states including New Orleans' negro quarter. From 1854-1868 there were epidemics in Sweden, Norway, Denmark and Germany, Austria, Hungary, Russia, Roumania, Turkey, Greece, thus becoming practically endemic over Europe but not especially among the military population.

The disease was epidemic in Ireland and England and in the Netherlands in the garrison at Arnheim (1866-1867), and again assumed importance as a military disease during the Civil War. Since 1856 there had been frequent epidemics in the United States, one in North Carolina, and one in New York State, and this slumbering prevalence was awakened by the military operations of 1861-1863. In the winter of 1861 it appeared in the Army of the Potomac, in Livingston Co., Mo., among both soldiers and civilians, and in 1862 among negroes sent by the Confederates to Memphis. It also was prevalent in 1862-1863 among troops in North Carolina. It became gradually disseminated from the seat of war until frequent and widespread epidemics were scattered over all parts of the United States until 1874.

The great predilection of cerebro-spinal fever for the military population, the reasons for which are now well understood, was especially emphasized by Hirsch. "Of 62 epidemics in France the malady in 43 was absolutely confined to the soldiery of the place, in six it was chiefly among the troops and only occasional cases among the townspeople, and in five it was equally common among civil and military. In Algiers four out of nine epidemics were among the French troops alone and four were among them and the other inhabitants equally. From the United States we have numerous accounts of the disease being restricted to the military, especially during the Secession War in 1861-1863". Other examples are numerous. Many of these outbreaks further emphasize the tendency of the disease to stick to one barrack or military detachment to the exclusion of others in the same encampment.

At the present time the interest in this disease is again aroused by the experiences of the English, French and Italians in the present war and by the entrance of the United States into it. The disease has been frequent in all the armies since the commencement of hostilities and reached epidemic proportions in England during 1915 especially among the Canadian recruits encamped at Salisbury Plain and in Australia. The experience of the French has been continuous and productive of a large literature on the clinical side especially. The experience of the English as crystallized in the report of the Medical Research Committee has especially enriched our knowledge of the bacteriology in its relation to specific therapy and to carriers.

Already in the cantonments of the United States, cerebro-spinal fever has taken an important place and while it is too soon

to say just what course it will pursue as regards increase there has been a steady rise in the incidence up to date, Dec. 14, 1917.

Weekly tables of the incidence of various diseases among United States troops have been published each week in the Journal of the American Medical Association.

The following abstract of Tables from the Journal show the situation so far as regards the United States troops:

WEEK ENDING	NEW CASES
Oct. 12	16
Oct. 19	12
Oct. 26	35
Nov. 2	18
Nov. 9	32
Nov. 16	50
Nov. 23	75
Nov. 30	55
Dec. 14	(in one camp 30) 86

THE ORGANISM.

The development of our knowledge of cerebro-spinal fever is an interesting chapter in medicine. While the diplococcus intracellularis meningitis, now considered the causative agent, was first clearly described by Weichselbaum in 1887, this event can truly be said to be less striking in its relation to the whole story than is usually the case when a definite causative organism of an infection is brought to light. No subject in medicine shows better the gradual growth of our knowledge from building stones fashioned one by one by many workers than the history of meningitis. Meningitis was first established as a disease entity separate from diseases of the brain itself by Morgagni in 1760. After a lapse of forty-five years Vieussieux (1805) described the Geneva epidemic. This was the first carefully presented clinical account, although the disease had been arousing interest before that time in America and its prevalence in New England (1806-1814) was shortly to give rise to a number of classical papers by Strong, North, Fish, Hale, and Miner. When we remember that this was a decade before the exodus of New England medicine to France to study under Louis and two decades before Elisha Bartlett and his book on Fevers, we may see here evidence of the first awakening in New England medical thought, which was to send young men to Louis in France and to produce James Jack-

son, Jr., Holmes, Shattuck, and the Warrens. While Morgagni recognized in general the difference between disease of the meninges and of the brain, inflammation of the pia as distinct from the dura mater was first pointed out by Porent-Duchatelet and Martinet in 1821 and the tuberculous, granular form was first distinguished by Guerin and Guersant.

The earliest clear description of the pathology of simple meningitis is found in the works of Cruveilhier (1834). The organism was undoubtedly seen by Gaucher in 1881. He found micrococci in the urine and blood of a patient with epidemic meningitis and in the exudate from the brain and cord post mortem. Ughetti (cited by Hirsch) found micrococci but stated that they had no particular characters separating them from other micrococci and he was unable to infect rabbits with fluid containing them.

Marchiafava and Celli announced that they found micrococci both within the leucocytes and free in the fluid in epidemic meningitis. A confusing element in the bacteriology of cerebrospinal fever was introduced by Jaeger in 1895. This observer found at autopsy in 14 cases a diplococcus which he considered to be the organism of Weichselbaum, but which stained by Gram's method in exudates and cultures though it was decolorized in sections. He occasionally saw chains and capsules in cultures. These observations coupled with the statement that it grew readily on agar, glycerine agar and bouillon at temperatures of from 22°-37°C. makes it evident that if Jaeger had any one organism at all it was not the meningococcus. The interest in these observations was out of all proportion to the importance of the work and led to marked confusion until the studies of Councilman and Mallory and Wright, Albrecht and Ghon, and Bettencourt and Franca and V. Lingelsheim finally established the *Diplococcus meningitidis* on a firm basis defining its bacteriological characters. The term Jaeger's coccus is still frequently found in the literature or found under the name *Diplococcus crassus* and is still a source of confusion. The writer believes that the use of either of these terms to designate improperly classified organisms which may happen to be found in, or through imperfect technique may appear to arise from, the spinal canal in cases of meningitis is unscientific, confusing and not necessary. The characters which defined the *Diplococcus intracellularis meningitidis* from a bacteriological standpoint were now definite and well understood; namely an aerobic gram-negative diplococcus requiring an animal pro-

toid for its growth, able to ferment dextrose and usually maltose, but not other sugars. This conception is quite satisfactory, but does not clearly distinguish between the meningococcus and gonococcus (a question which perennially has caused confusion and is destined to cause more unless a new instrument of differentiation is placed in our hands), though it did serve to separate it from such organisms as the so-called Jaeger organisms, micrococcus pharyngis siccus, and micrococcus catarrhalis. The next method of value in further defining the meningococcus was the discovery of the fact that it possessed the power to develop specific agglutinins in animals (Albrecht and Ghon). This method brought out some interesting facts largely through the work of Elser and Huntoon. These results showed that through the application of agglutinin technique to the problem it could be shown that there were group agglutinins common to the meningococcus and gonococcus and that about forty per cent of true meningococci did not agglutinate at all with the antimeningococcus serum. In the light of the work of Dopter, Arkwright, Gordon, etc., to be referred to presently, we can of course understand this failure of forty per cent of the strains to agglutinate. Absorption tests had to be resorted to sometimes to bring out the presence of meningococcus agglutinin in the presence of a gonococcus since an antimeningococcus serum would sometimes agglutinate a gonococcus in a dilution which was incapable of affecting the meningococcus tested. The same year (1909) that Elser and Huntoon published their valuable paper on the bacteriology of the meningococcus and allied organisms, Dopter found in the nasopharynx an organism identical with the meningococcus except that it did not agglutinate with antimeningitis serum, and did not react to a modification of the Pfeiffer phenomenon devised by him. Nor did it respond to the intravenous reaction of Briot and Dopter which depended upon the anaphylactic reaction developed by injecting a mixture of meningococci and antimeningitic serum intravenously into a guinea pig. Dopter called this new(?) organism the parameningococcus, and it was soon found in cases of meningitis by several observers. Meanwhile (1906-1907) Flexner had put the specific serum therapy of the disease on a firm basis and favorable results from the use of his serum prepared from a large number of different strains were quite generally reported. During the period from 1909 when Dopter called attention to the meningococcus till 1915, the Rockefeller Institute perfected the serum and its use and the observations of Dopter

were confirmed and extended by Martha Wollstein, who found that while meningococci fell in the main into two large groups corresponding to the ordinary type and the strain which Dopter had called parameningococcus, still each group was not strictly consistent within itself and many strains of each group were necessary for the preparation of a thoroughly satisfactory therapeutic serum.

During this period antimeningitic serum was manufactured commercially by several concerns each being left to choose its own methods and apply its own standards of efficacy to its product. The result was that the outbreak in England found the army supplied with quantities of apparently worthless commercial product with a resulting loss of life that caused serious concern to all and even shook the confidence of some clinicians in the serum treatment completely. The extreme unreliability not only from a specific point of view but also from the standpoint of ordinary care in preparing sera of acceptable physical characters was strikingly shown by Amoss, and to meet the rapidly increasing demand for a proper serum the Rockefeller Institute again resumed its manufacture and Amoss and Wollstein worked out an improved and more rapid method. By this method which is a modification of the method used for preparing dysentery serum, they are able to obtain a suitable serum from a horse in from 8-12 weeks. The method itself is important enough to warrant a rough sketch of the technique. A 24-hour slant of meningococcus is washed off with 2 cc. of saline and of this 0.1 cc. diluted to 15 cc. is given to a horse intravenously. The temperature is taken hourly beginning four hours after the injection and, the record continued until the temperature begins to fall. The following day 0.2 cc. is given and the next 0.3 cc. with the same record of temperature. After an interval of a week the technique is repeated starting with 0.3 cc. but regulating the subsequent doses of this period so that the temperature rise is from 2.5°C. to 3.0°C. after each dose. Thus at weekly intervals, 3-day series of injections are carried out, the dose being regulated by the temperature and of course increasing weekly. After the second series it is necessary to desensitize the animal on the first day of each series by a small preliminary dose of 0.1 cc. giving the full dose one hour later. By adding new strains as the size of the dose enlarges and by alternating the bacterial emulsion with series of injection of autolysate, a potent serum is produced in from 8-12 weeks.

Methods to Facilitate the Isolation of the Organism.

The English workers have especially added a great deal to our knowledge of the growth requirements of the meningococcus and have perfected technical methods for the isolation and detection of the organism in practical work. Since animal protein, or animal protein derivatives are necessary for the growth of the meningococcus most of the methods for preparing media are based on this principle. It is necessary to keep several small points in mind, however, before the use of any media whatever is considered. One of these is that in a certain per cent of cases the organism is present in such small numbers in the fluid that an attempt to cultivate it by any method whatever may be unsuccessful. In recognition of this fact Cohen and Markel have shown that a larger number of successes result if the primary culture is grown under a lowered oxygen tension. Oliver and Wherry had shown that the gonococcus grew much more luxuriantly this way and on account of the close relationship between the two organisms bacteriologically, Cohen and Markel applied this idea to the meningococcus with the same successful result. The atmosphere low in oxygen is brought about by pushing the cotton plug down the tube a short distance and connecting the primary culture by a cork and rubber tubing with a similar tube on which a fresh slant of *B. subtilis* has been planted.

It is well known, of course, that a considerable quantity of spinal fluid should be planted. The method of choice is to allow several drops of the fluid to drop directly in the culture tube at the bedside. If this is impossible the chance of success varies inversely as the length of time which elapses between the puncture and the planting. Enrichment methods may be made use of and are more productive of success with perfectly fresh fluids than with those that have been allowed to stand. Enrichment is carried out by incubating the spinal fluid either alone or after the addition of citrate and glucose solution. Denehy got the best results by incubating the spinal fluid itself. It is important to warm the media to body temperature before allowing the spinal fluid to flow upon it, a fact probably well known to all workers and applying also to the gonococcus, but especially insisted upon by Douglas.

Media.

Flexner recommends the usual sheep-serum-water-glucose agar adjusted to + 0.4 phenolphthalein. Beef or veal infusion glucose agar is adjusted to 0.4 +. Sheep serum, one part and

distilled water three parts are mixed and steamed in the Arnold Sterilizer on three successive days for thirty minutes or in the autoclave at fifteen pounds pressure for forty minutes. One cc. of serum water is added to each five cc. of melted agar cooled to 50°C. Slants containing 5 cc. and tubes for plates containing 10 cc. are made and melted as required for plates.

A medium which Flexner recommends even more strongly is as follows: Into a Petri plate 0.25 cc. of defibrinated rabbit blood laked in 0.5 cc. of sterile water is mixed with 10 cc. of melted agar cooled to 45°C. Flexner states that the colonies reach a larger size on the haemoglobin medium and that certain meningococci grow on this medium which fail to develop on the serum water plates. Cohen and Markle grew their partial tension cultures on Martin's basic sodium phosphate pleuritic fluid medium.

A medium for the maintenance of stock cultures has been devised by Roos. It is a modification of the pertussis medium of Bordet and Gengou. Potato extract is first prepared by peeling and cutting the potato up fine and washing in running water for two hours. One hundred grams of this is weighed out, and placed with 200 cc. of water containing 4 per cent double distilled glycerine free from acid. The mixture is autoclaved for forty minutes, allowed to stand over night and drained through cheesecloth. Fifty cc. of this potato extract, 150 cc. of 0.65 per cent sodium chloride, and five grams of agar are steamed until the agar is melted. Tube without filtering and sterilize in autoclave forty minutes. When wanted melt and add sterile defibrinated horse blood in desired amount. Gordon, Hine and Flack made an elaborate experimental study of the growth requirements with the result that they have given us probably the best methods for routine material. These investigations resulted in their finding that extract of pea flour especially promoted rapidity of growth and that extract of raw wheat germs especially promoted longevity on the part of the organism. The medium which they recommend is a neutral trypsinized beef heart broth agar to which 5% of sterile pea flour extract or pea flour and wheat germ extract is added. The best enrichment for this medium the authors state to be sterile laked rabbit blood prepared as follows: (Note by Park appended to article by Krumwiede).—A rabbit is bled into 50 cc. of 5% sodium citrate. Ether to the amount of 10 per cent is then added to the whole and shaken and allowed to sediment for 24 hours. The clear, hemolyzed blood fluid is then drawn off

and bottled with a little excess of ether. Four cc. of this blood is then added to each 200 cc. bottle of agar after melting and cooling to 50°C. The full details of the preparation of the pea flour trypsinized beef heart broth agar are too extensive for this article and reference must be had to the original. By this medium the use of peptone is done away with as is also glucose.

Dorothy Jordan Lloyd prefers bullock blood added to trypsinized beef heart broth agar coagulated by heat and clarified by centrifugation or standing and filtration through glass wool on a Buchner funnel. She believes this superior to pea flour agar.

Undoubtedly the method worked out by Gordon and his colleagues is the best for work on a large scale in that it does away with peptone, that pea flour may be easily procured and that the method of laking rabbit blood for enrichment is practical and easily carried out.

Agglutinins.

The grouping of strains according to their agglutinin reactions has been carried out in some detail by recent workers without adding anything essential to the earlier observations of Wollstein, Elser and Huntoon and Dopter. There is a tendency to still further divide the strains with a resulting classification into three or four groups which may or may not be of service, and it may be that, outside of two great groups to which at least 80% of all strains belong, it is wiser to have a heterogeneous group comparable to the Group IV Pneumococci to which all other non-descript meningococci might be assigned. The important point to bear in mind is the necessity in antiserum manufacture of immunizing, not only to the two main groups but to as many atypical forms as determined by the agglutinin reactions, as possible.

Arkwright found that thirty out of thirty-five strains belonged to the two great groups, in the proportions of 18 of the normal to 12 of the para type. Two of the remaining strains showed evidence of an intermediate position between the two main groups.

Ellis, classified forty-six strains under two groups I and II; II was identical with the parameningococcus of Dopter.

Netter's experience with 323 cases since 1908 confirms the reliability of the agglutinin test for classifying the type of meningococcus. Netter found type B (para) in his last four cases accompanied with purpura and also in a case of meningococcus sepsis preceding the meningitis by several weeks. This is of interest when one recalls the fact that after Dopter discovered the

organism in the nasopharynx the first report of the organism causing disease was the report of a case of malignant purpura by Carnot and Marie. (Cited by Heiman and Feldstein.)

Other attempts to classify into four types have been made by Nicolle, Debians and Jouan and by Gordon without very clear justification.

The methods of agglutination are the usual macroscopical ones. Amoss states that a satisfactory serum should possess the ability to agglutinate each type in from 1-400 to 1-1000 dilution.

A rapid method of agglutination suitable for the identification of cultures has been devised by Ruth Tunnecliff. Equal parts of antimeningitic serum, whole human blood in sodium citrate (1 part blood to 2 parts of 2% citrate) and a suspension of organisms are mixed, incubated in an opsonizing pipette, for ten minutes, smeared on a slide, stained with carbol thionin without fixation and examined. The agglutination is evident in the case of positive cultures.

Another method is a macroscopic slide method published by Krumwiede, which consists of rubbing the growth with a platinum wire loop into a 1-10 dilution of immune serum using normal horse serum as a control.

Krumwiede also recommends as the most suitable culture medium serum water agar containing 1% saccharose and 1% lactose with 1% of Andrade indicator with reaction set to this indicator. This medium is of value for exclusion of the mouth cocci since these usually ferment both sugars. In spite of the apparent parallel between therapeutic efficacy as determined by the agglutinin methods, McCoy doubts whether we are yet in a position to require commercial houses to meet any specific standards. He mentions agglutination, complement deviation, opsonic index, animal protection test, and therapeutic trial as possible methods and doubts whether any can be applied in a practical manner. In the light of accumulated experience it would seem that there is ample reason to assume that the therapeutic efficacy of the serum, if not parallel to, is at least indicated by, the agglutinative power and manufacturers might be required with justice to all concerned to state the number of distinct strains as tested by the agglutinins from which the serum was prepared as well as the dilution at which agglutination takes place. Robinson, however, advises the use of animal protection tests, by injecting with antiserum intraperitoneally and following this by a dose of meningococci which will kill an unprotected mouse.

Autopsy Findings.

The recent experience has added perhaps nothing to our previous knowledge of the general pathology of this affection. The report most interesting to the writer is that of Denchy, who reports his experience with three hundred sixty-eight cases, two hundred and seven of which were in soldiers. There were seventy autopsies. Denchy testifies to the value of the potassium permanganate test on the spinal fluid in very early cases. It should be noted, however, parenthetically, that the slightest trace of blood in the fluid, much too little to be detected macroscopically, will give a positive KMnO_4 reaction. Denchy lays stress on a large number of organisms free in the fluid as an unfavorable prognostic sign. Mixed infections with pneumococci were found. Blood cultures were positive three times, once with a complicating cerebral abscess and once with ulcerative endocarditis. Pan-encephalitis was a feature of the acute cases at autopsy. Internal hydrocephalus was assigned as the cause of death in 16 per cent. The internal hydrocephalus cases fell into two groups, those occurring in the acute stage and those coming on after recovery from the active process. Lobar pneumonia due to the pneumococcus was the cause of death seven times. There were three instances of recent capsular hemorrhage, in two of which there was rupture into the ventricle. There was chronic nephritis in 20%. Cerebral abscess was found twice, cardiac thrombi and lung infarcts twice, and in one of these polyserositis and pericarditis. Pyopericardium was found in 11%. There were petechial hemorrhages of the serous membranes in 13%, pyelitis in 2 cases. The spleen was enlarged in 41%.

Denchy lays stress on "a hemorrhagic condition of the brain especially the base". In three cases he found the organism in stained blood films. Gram negative diplococci were obtained both ante and post mortem from pericardial fluid and from elbow and knee joints. In five of nineteen complicating pneumonias he found Gram negative diplococci.

General enlargement of the lymph nodes was frequent. Aortic atheroma (type?) was present in 22%. The presence of purulent bronchitis in the majority of cases suggested this location to Denchy as the possible primary seat of the disease.

The hemorrhagic tendency is especially emphasized. Petechiae in the ependyma and the hemorrhage at the base mentioned above were common. There were two cases of multiple hemorrhage into the lung tissue. Purpura of the skin was com-

mon. In one case the intestinal canal was filled with blood clot. There was hemorrhagic enlargement of the adrenals in two fulminant cases. The generalized character of this affection is well impressed upon us by this summary and the justification of the term cerebro-spinal fever rather than cerebro-spinal meningitis is well brought out.

A. de Verbizier lays great stress on the large number of cases of meningitis found during the war which were due to other organisms than the meningococcus. Besides the tubercle bacillus, streptococcus and pneumococcus, he mentions cases due to tetragenus, paratyphoid A, and pneumobacillus, and says that though in times of peace the meningococcus is the all-important organism, meningeal infection with the others is not at all uncommon in time of war as recent French experience has shown.

Mode of Transmission.

Beginning with the discovery of Albrecht and Ghon in 1901 that healthy people associated with cases of meningitis harbor the meningococci in the nasopharynx, the knowledge of the role of carriers has constantly grown. Meningitis is almost unique among infectious diseases in the fact that its dissemination is due exclusively to carriers. The organism does not live outside the body except on special media. It is not carried from person to person on clothing, food or special articles. In clinical practice it is very rare for physicians and nurses or other attendants to contract the disease, but the greater portion of all persons associated with meningitic patients become carriers. Carriers also spread the organism to others and produce new carriers.

The nasopharynx is the normal habitat of the meningococcus and from healthy carriers who harbor the organism in this situation the disease is spread. In all epidemics the number of carriers is much greater than the number of cases of the disease. The particular conditions which cause a new carrier to succumb to his infection and which favor the generalization of the local process in the nasopharynx are absolutely unknown. The situation cannot be better expressed than in the words of Dopter quoted by Verbizier:

“Actuellement les porteurs de méningocoques doivent être considérés comme les anneaux d’une chaîne interrompue qui relie dans une même agglomération, et même d’une localité à l’autre, les cas de méningite cérébro-spinale qui paraissent les plus indépendants les uns des autres. Dans un milieu atteint de méningite

cérébro-spinale, la rhino-pharyngite méningococcique apparait comme la véritable maladie contagieuse et épidémique qu'en apparence; *il n'existe pas d'épidémie de méningite, mais des épidémies de rhino-pharyngite compliquées parfois de méningite*".

Thus it seems most rational to consider the meningeal involvement in the light of a complication and to look upon it as we do joint, pericardial, or eye involvement by the meningococcus as in a sense an accident in the course of a widespread epidemic of meningococcus rhino-pharyngitis. We know very little concerning the reasons for tissue predilections on the part of bacteria. We do not know the exact conditions that determine hematogenous invasion, or endocardial predilection or joint involvement but we do recognize these things as facts. We know these facts to be true of all bacteria which occasionally become hematogeneous invaders. The typhoid bacillus, streptococcus and pneumococcus frequently develop tissue predilections and typhoid spine, streptococcus osteomyelitis, and pneumococcus meningitis are of frequent occurrence. Complications, so-called, of epidemic meningitis are almost as common as meningitis itself so that meningococcus arthritis, panophthalmitis, pneumonia, pericarditis, endocarditis, otitis media, etc., are constant phenomena in any series of cases. We should, therefore, not look upon this disease as primarily a meningitis but as an epidemic rhinopharyngitis which frequently, (10-20% of the cases) involves the meninges and also the blood and other tissues.

As to the method of generalization from the rhinopharynx nothing positive is known. The two likely routes are, (1) lymphatic, through the cribriform plate to the base of the brain, and, (2) hematogenous by first becoming a (transient?) septicemia. The preponderance of accumulating clinical and pathological evidence favors the hematogenous route. Indeed the writer believes on the basis of his autopsy experience with so-called otitic meningitis (excepting the local subdural abscess which occasionally becomes generalized) due to streptococcus, streptococcus mucosus and pneumococcus, that the invasion in these types is not through the bone and by the labyrinth lymphatics but hematogenous.

It is probable that following the catarrhal stage of nasopharyngeal inflammation and coryza there is a stage of blood invasion of greater or lesser severity and duration after which there is a localization in the meninges or in other organs or both. Sometimes the meningococcus does not localize in the meninges and

we have a simple meningococcus sepsis. The literature of this phase of the subject is so extensive as to make it impossible to review it completely. Apparently the first blood culture was obtained by Gwyn; since then very large numbers of cases have been reported. The purpuric and petechial forms are especially associated with the meningococcemia. Bovaird has reported a case with meningococcus sepsis, iridocyclitis, and sterile spinal fluid. It is probable that if the cases could be cultured in the pre-meningitis stage or very early after the onset of meningeal symptoms, a very large percentage of blood cultures would be positive.

Detection of Carriers.

All persons in close contact with a meningitis patient or who have been closely associated with him at home or in barracks, should be immediately examined for carriers. Rosenthal believes that the meningococcus sets up a typical inflammatory induration of the rhinopharynx characteristic on clinical inspection and yielding a characteristic picture by a stained direct smear. The best method of detecting carriers is by smearing plates of appropriate

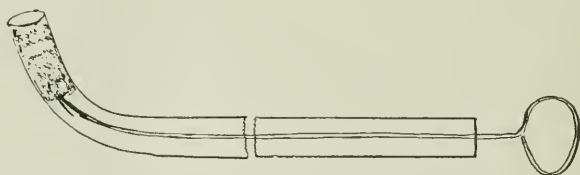


FIG. 2.—WEST TUBE.

media with swabs taken with a West tube. This tube (Fig. 2) is so constructed that the swab does not become contaminated with mouth secretions until the extremity of the tube is up behind the palate in the nasopharynx. The plates should be immediately incubated in a moist atmosphere, the likely colonies being examined by agglutination, for instance by Tunnecliffe's or Krumwiede's rapid method.

Considering what we know of carriers and the mode of dissemination of the meningococcus and the incidence of meningeal involvement, the sanitary recommendations which would be given out regarding its control in military life are easily deduced and quite definite. The following would be a fair sample of general recommendations:

1. On account of the influence of bodily fatigue on the incidence of meningitis all new troops should be broken in to training as gradually as is expedient.

2. The meningococcus dies very quickly except in warm, moist air. Sleeping quarters in barracks should be cool, especially well ventilated and the closing of the ventilator should be prevented by mechanical means or by a special patrol.

3. Meningitis is most apt to occur in newly arrived troops after the hardships of a journey, and therefore, new troops should not be quartered in the same rooms with troops already on the ground, but should be placed in barracks by themselves for at least two or three weeks before they are allowed to mingle intimately with the other men.

4. In the event of an outbreak large or small, all members of the detachment who have been occupying quarters, especially sleeping quarters, with the patients, should be considered carriers and potential cases. They should be removed from barracks and put under tentage on high, sandy ground with as little crowding as possible and practically relieved from duty requiring physical exertion.

While these precautions will suffice for the handling of an outbreak we are not quite so clear as to how long conditions of segregation should be imposed. The treatment of meningococcus carriers is in the same unsatisfactory state as the treatment of carriers of other diseases. Gordon and Flack got the best results with one per cent chloramine spray though by none of the methods used were the results sufficiently striking to be recommended with confidence in practical work. In general it should be said that where the laboratory force is available and the detachment not too large a systematic search for carriers should be made, releasing those who have two negative cultures and attempting to treat the rest.

In spite of Black and Sophian's confidence in prophylactic vaccination the general belief in its efficacy does not seem to be great.

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TETANUS AND THE WAR—A REVIEW OF THE LITERATURE.*

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Tetanus is the "black beast" that lurks in the shadows for the convalescent wounded soldier. The maelstrom of the battlefield may be safely passed; the soldier rejoices in having received only a slight shell-wound, and is invalided home for a few weeks; but terrible indeed may be the end if that bit of shell has carried with it the spores of the anaerobic tetanus bacillus. As all statistics of other wars have been surpassed in the present conflict, it is not surprising that there has been an enormous number of cases of tetanus reported. It is a matter of comment however, that in 1914 especially, the ratio of tetanus infections to the total number of wounded far exceeded that found in previous records.

The literature on tetanus as it relates to the war during the past three years has been voluminous as evidenced by a glance at the bibliography and it has not been possible in this paper to review it completely. To correlate these statistics will be more properly a task for the historian of the future. Statistics at this time are not popular, nor are reports any too authentic from the various belligerent nations. There are some articles however, that stand out as adding a great deal of information to our previous knowledge of tetanus. Robertson, of the University of Minnesota, in reporting his studies on tetanus, has thoroughly reviewed the early literature, and has emphasized the necessity of applying our knowledge of prophylaxis to war surgery. Our own Medical Corps especially may profit by the official reports of the surgeon-generals of the British Forces. Sir David Bruce, Surgeon-General, Chairman of the War Office Committee for the

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study of tetanus has made an analysis of the cases of tetanus treated in home military hospitals that are especially valuable. His last report this year (September, 1917) makes public the statistics of these cases to the end of 1916.

The incidence of tetanus to the total number of wounded in the British forces was 16 per 1,000 in September, 1914; 32 per 1,000 in October, 1914. September 8, 1914, the telegram arrived at the front, "Earl Kitchener desires information as to whether antitetanus inoculations are being practised for the wounded and whether, if not carried out in the field units, they are carried out in communication units. He wishes all to be impressed with this." In November, 1914, the ratio fell to 2 per 1,000, and this has been the ratio with very slight fluctuations since then. This fall is undoubtedly due to the introduction of prophylactic injections of antitetanic serum for all the wounded. We might compare with these figures the early reports of the incidence of tetanus among the Germans of 6.6 per 1,000 at one base (report of Madelung). A report by Kümmell places the incidence among the German wounded at the same unusually high percentage, 6 to 6.5 per 1,000. The data from other sources are not quite so reliable. Italy does not seem to have so much tetanus although there are many references to individual groups of cases. The French figures are not complete. Courteaud reports recently that since the beginning of the war there have been 58 cases of tetanus among 60,000 wounded appearing at Cherbourg. This is a surprisingly low number as it is less than 1 per 1,000. However, the same article states that in the region of Cherbourg tetanophobia is rampant among soldiers, sailors and civilians and they come to the hospital for prophylactic injections for the least scratch. In fact the author pleads discrimination lest the available supply of serum be exhausted in useless administration.

A report by Bazy in 1914 states that when prophylaxis was practised by every wounded man the incidence was 4.18 per 1,000 and when the injections were made only in suspicious cases the incidence was 12.79 per 1,000. Also that in a batch of 200 wounded soldiers 100 received prophylactic injections, and there was one case of tetanus. In the second 100, because of no available serum, there were 18 cases of tetanus. It is evident then that at times at least this has been a big factor to deal with in the French wounded. The reason for the overwhelming incidence of tetanus in the present war can be attributed doubtless to what has often been referred to as the tetaniferous fields of France, and of Flanders.

In this connection it is interesting to review the statistics of some of the wars of a generation ago, long before the discovery of the tetanus bacillus by Kitasato in 1889, and the prophylactic antitetanic serum of von Behring. In the Crimean war the English report 12,094 wounded with only 9 cases of tetanus or 1.5 per thousand. The Medical and Surgical History of the War of the Rebellion gives a total of 246,172 injuries among the soldiers of the United States Army, with 505 cases of tetanus, or slightly more than 2 per thousand. It is stated that in the Franco-Prussian War, there were 350 cases among 95,000 wounded, an incidence of 3.5, and in the Russo-Turkish war (1877-1878), 66 cases among 51,700 wounded—the very low ratio of only 1.2 per thousand. It would seem then that at the present time following out all of the measures that modern science and strict military discipline can impose, the very best that the armies of the world can do is to keep the incidence of tetanus in their wounded to about the ratio that has been reported in past conflicts.

A discussion of the character of the disease may not add anything to our knowledge of the subject. However, it is of interest to note the many types that have been reported.

It must always be remembered that we are dealing with a local infection, with a virulent toxin making its way to the central nervous system by way of the perineural lymphatics. The character of the disease is affected by the extent of the injuries, many wounds making many foci of infection, and also by the treatment of the wound at the first dressing station.

The classic picture is that of so-called “tetanus descendens”, common to man and horse. In this condition trismus, or “lock-jaw” is the first symptom. The spasmodic contractions then occur in the various parts of the body, appearing in their sequence from above downward. The opposite of this condition is “tetanus ascendens”, which is first localized to the wounded limb, and then extending upward it becomes general.

There are many reports of localized tetanus. Usually the patient complains of pain before the spasms and board-like rigidity of the muscles are apparent. This should always be thought of if the patient is complaining of “rheumatism” in the wounded limb. For years it has been thought that the lower limbs are the more common locations for wounds from which tetanus develops. This is confirmed apparently by war statistics. McArdle also mentions that the thumb is a rather common location for wounds that result in tetanus, the lymphatics of the median nerve quickly

carrying the toxin to nerve centers. Wounds about the head may harbor the germs of this disease, but it is unusual for wounds of the chest or abdomen to be the focus of tetanus.

One rather common type of disease is delayed tetanus. Usually in such cases at least one prophylactic dose has been given at the front. This undoubtedly modifies the type so that instead of the acute, flamboyant, quickly fatal tetanus, there is a period of latency. Miller, Inspector of Tetanus at Edinburgh, reports a typical case. The man was wounded October 22, 1916, at the Somme, and received prophylactic treatment on that day and also October 30. November 22 there was a slight rigidity of the left arm. December 15 he returned to duty. January 5, 1917, he complained of a pain in the head. January 9 he was sent to the hospital where two days later (January 11) a definite trismus was noticed. In spite of active treatment with antitetanic serum the patient died January 13, or eighty-three days after he was wounded.

Barling reports three cases of delayed tetanus, one occurring fifty-one days, another fifty-three days after injury; both of these patients recovered. The third patient developed tetanus forty days after injury and died finally of gas gangrene which set in seventy-three days after the injury and forty-two days after the healing of the wound. Dean, in his report of twenty-five cases, states that in ten cases the incubation period was more than fifty days, the longest time of onset being one hundred twenty-seven days after the patient was wounded, but thirty-one days after an operation. Another case occurred one hundred two days after the patient was wounded, and one hundred days after an operation.

Two of Foster's three cases of delayed tetanus are of special interest. The third case developed after an incubation period of eighty-six days. Cases 1 and 2 were patients whose wounded arms were injured by falls during convalescence. The first patient developed tetanus one hundred forty-six days after receiving the wound, and the second one hundred six days after the initial injury. All three of these patients recovered. In this connection there is an interesting report in the German literature by Doberer of an Italian prisoner of war who developed tetanus one hundred twenty-eight days after injury, from which he recovered. A month later scraps of shell were removed and tetanus again flared up for five days. Mice injected at this time with material from the wound developed tetanus. The patient recovered, so

that the dictum of Coombe, in his article on this subject to "let sleeping dogs lie" might be well heeded. He suggests that there should be great care in any interference with a granulating wound in war-surgery.

Still another case history reported by Westwater states that forty-two days after the first attack his patient developed a second attack from which he died. Constant vigilance seems to be necessary to avoid late or recurrent tetanus in instances in which the disease might be expected to occur.

Both Surgeon-Generals Makins and Bruce report the occurrence of tetanus developing as a complication of trench foot. The latter states that in the last few weeks of 1916 there were fifteen cases developing after "trench foot". He emphasizes the importance of giving weekly prophylactic injections of serum in this condition.

There would seem to be little difficulty in diagnosing tetanus if one keeps in mind the various types that may occur. Pribram states, however, that it might be necessary, as it was in two of his cases, to differentiate Tetany from Tetanus. The presence of irritability of the facial nerve, of a strained position of the hand, and of isolated adductor spasms are mentioned as diagnostic points in Tetany.

The prognosis in tetanus depends now as ever on the incubation period, on the rapidity of onset, and on the duration of the disease. Modern experience makes no change in the old statement of Kanthack that "fatality is in direct proportion to rapidity of onset, and inversely proportional to the duration of the disease". In fact Hippocrates stated that "such persons as are seized with tetanus die within four days, or if they pass these they recover".

As has been mentioned, prophylactic injections undoubtedly have much to do with the prognosis. The late tetanus that occurs after antitetanic serum has been administered at the time of the first dressing, has usually proved to be less fatal. Sir David Bruce says: "The incidence of tetanus among wounded men falls sharply on the introduction of prophylactic injections of antitoxin, and it is much to be desired that the primary injection be followed up by secondary and further prophylactic doses as long as the wound remains suspicious."

We in the United States are not unexperienced with tetanus. The Journal of the American Medical Association each year since 1903 has gathered reports of "Fourth of July tetanus", and the

lay press has done much to educate the public as to the danger that lurks in the apparently simple powder-burn. In the years 1903-1915 inclusive there were 1,119 cases of tetanus resulting from accidents arising in the celebration of Independence Day, and 991 persons died. There is, however, something very encouraging in these amazing statistics, that is, the years have shown constant and remarkable improvement. In 1903 there were 415 cases and 406 deaths; in 1912, 7 cases and 6 deaths; in 1913, 4 cases and 3 deaths; in 1914, 3 cases and 3 deaths, and in 1915, only 1 case. Since then there have been no cases. Prophylactic injections must have played a great part in making this most satisfactory change, though the regulations in the large cities that make for "a sane Fourth" have made accidents rare instead of common.

The advice of the surgeon-generals with the British Forces is to do very little locally in attempting to remove the infection after the first operation. If foreign bodies can be removed or amputations are necessary, precede such procedures with prophylactic injections.

Tizzoni showed experimentally that dressings in which antitetanic serum had been dried, when applied to wounded surfaces infected with tetanus, protected the animals from the disease. It has been suggested in the Italian literature that this be given clinical trial, but there are practically no statistical reports as to its efficacy.

As soon as symptoms of tetanus appear, treatment is carried on most strenuously, and with watchful care. In our civil war the treatment is frankly described as "empirical to the last degree". There are mentioned twenty-eight different drugs that were administered by mouth, and sixteen different sorts of local applications for the cure of tetanus. It is little wonder that the mortality was 89.3 per cent. Though in spite of our best efforts we may expect an incidence little better than in previous wars, still the methods of treatment now at our command are rational and hopeful.

Statistics regarding mortality vary. Sir George Makins, Surgeon-General, consulting surgeon to the British Armies in France, has stated within the year that in spite of treatment the mortality is above 70 per cent of all cases treated. It must be remembered that these patients were severely wounded and could not be transported to England.

The reports of Sir David Bruce are more encouraging. From

the home military hospitals there have been four different series reported: In 1914-15, 231 cases, 57.7 per cent mortality; in 1915-16, 195 cases, 49.2 per cent mortality; in August and October, 1916, 200 cases, 36.5 per cent mortality; October to December, 1916, 100 cases, 31 per cent mortality. He has hopes that the mortality may finally be reduced to 20 per cent. The incubation period tends to become longer, as only 12 of the last 100 cases occurred in less than ten days from injury. There were no deaths at all in 29 cases in which there was localized tetanus.

Treatment is specific, and symptomatic. Specific treatment consists in the administration of antitetanic serum. As prophylactic measures, 500 to 1,000 U. S. A. units are injected subcutaneously, the first as soon as possible, and then at weekly intervals until the wounds heal. After symptoms develop the manner of administration and the dosage has been the subject of some unfortunate controversy. At the outset subcutaneous or intramuscular injections of several thousand units may neutralize the toxin. Leishman and Smallman insist that this is the best method for treating the disease throughout its course. They divide the dose and inject some into the muscles of the injured limb if feasible. Daily doses of 10,000 units are given for the first few days. Some authors have advocated injections into the main nerve trunk if possible, especially when localized tetanus is the first sign. Though early reports advocated the intravenous administration of serum, this has been practically discarded as the results do not warrant the great risk of anaphylaxis that all patients run.

In the home military hospitals in England the method used uniformly is the intraspinal. Fluid is first withdrawn and as many units as can be safely given are introduced. An ordinary first injection is 3,000 units, although by using the concentrated form, the globulins only, as much as 30,000 has been injected intrathecally. With this is combined intramuscular injections. Professor Sherrington conducted a series of experiments for the war office committee for the study of tetanus. Twelve infected monkeys were treated intramuscularly, all died; while of 18 monkeys treated intrathecally, 13 recovered. This would seem conclusive evidence of the advantage of introducing antitoxin directly into the spinal canal.

* Sir David Bruce reports the cases from December, 1916, to March, 1917. In this period there were 100 cases treated in the home military hospitals, and the mortality was only 19 per cent. (*Lancet*, London, 1917, No. 25, ii, 925.)

The symptomatic treatment of the disease is sedative and antispasmodic. The treatment of Meltzer and Auer with magnesium sulphate was advanced in this country several years ago, and has many advocates, especially in Germany. It consists of injecting concentrated solutions of magnesium sulphate which has a marked antispasmodic effect. If given subcutaneously it is used in 25 per cent solution. Not more than 2 cc. nor less than 1.2 cc. per kilogram body weight is injected four times a day, the patient being lightly etherized. This is the advised routine method of administration. Occasionally the same dose may be injected deeply into the muscles of the thigh. Massage should be administered, and the etherization continued for twenty minutes following the injection. As an emergency measure magnesium sulphate may be injected intravenously in isotonic solution (3 per cent) at the rate of 5 cc. per minute. The spasm may be controlled for a longer time by intraspinal injection of 25 per cent solution, giving 1 cc. per 10 kg. body weight. The dangers lie in the possibility of paralysis of respiration. When given intraspinally, the fluid may be drawn off from the canal if this catastrophe occurs. Meltzer also advises the use of his pharyngeal insufflation apparatus for the maintenance of artificial respiration. This method after a few trials has been practically abandoned in England. The same might be said regarding the Bacelli treatment with carbolic acid. This treatment, however, seems to meet with favor in Italy. Carbolic acid may be used in 1 per cent solution injecting 40 cc. up to 70 cc. daily. The action is supposed to be both antitoxic and sedative. The reports in the literature are not very favorable. When this is the only method of treatment the cases are uniformly fatal. When combined with serum treatment recoveries are reported but of course this nullifies any deductions as to the value derived from the phenol.

In conclusion, then, we may state in substance the summary with which Sir David Bruce closes nearly all of his reports. Prophylactic injections must be carried out persistently for all wounded, and "trench foot" cases. The most hopeful cases are those of late or delayed tetanus. Reports are not conclusive regarding the effects of serum therapy. Treatment is outlined as follows: (a) Rest, sleep, food; (b) surgery must be early, later on do not disturb the wounds; (c) administer large doses of antitoxin intrathecally, and intramuscularly, or subcutaneously; and (d) in addition, if necessary, use the common sedatives, morphia, chloral, or chloretone.

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NOTE ON GAS GANGRENE.*

A. S. WARTHIN

The most important article on the general pathology of "Gas-gangrene" or "Acute Bacillary Gangrene" is that by *Bashford*: —*British Journal of Surgery*, April, 1917, p. 562. He emphasizes the fact that the anaerobic bacilli found in wounds of warfare are pathogenic when in combination with one another and the combinations in which they occur in gunshot wounds are exceedingly virulent. While the bacilli multiply mainly in the aerolar tissues of the endomysium, their products destroy the endothelium of the blood vessels and lymphatics, the muscle fibers and the blood. The necrosis of lymphatics, capillaries and veins, with hemolysis and thrombosis, is the predominating feature of the rapid spread of the infection, with the accompanying degeneration and necrosis of the muscle fibers, and later, the formation of gas. The production of gas is a late secondary phenomenon attracting attention from its mere peculiarity. It does not play any part in the spread of the infection, although it increases the swelling. The formation of gas occurs in tissues already long dead. The name "gas-gangrene" is unfortunate. *Bashford* suggests that the term "acute bacillary gangrene" or "war gangrene" be substituted for it. The restriction of the most serious forms of infection to long muscles is explained by the vascular arrangements and the large mass of tissues suddenly involved. The

* Owing to exigencies of space this article has of necessity been reduced to its present size.

spread of infection is promoted, not only by the actual severance of the blood-supply, but also by thrombosis, coagulation or stagnation of the blood, especially in the capillary and venous circulation and stagnation in the lymphatic circulation. Bacillary invasion may be stayed by maintaining the arterio-venous and lymphatic circulations or by rapid substitution of fluids and cells used up in combating the infection. The danger is not on the surface; it is in the deep parts. Early surgical procedure is indicated, stopping only when an efficient circulation can be maintained, preventing the products of the organisms from damaging fresh vascular areas, and preparing fresh dead muscle for invasion. The absence of leucocytes in the clear or blood-stained fluid of bacillary gangrene results, not only from the damage to vessels, but from a strong antichemiotactic action where there is massive invasion. Constitutional symptoms arising from interference with the cardiovascular and heat-regulating mechanism may ultimately supervene and cause death. The opposing views concerning the pathology of gas-gangrene, as given by *D'Este Emery* and *Taylor* are reviewed in an article by *Wallace*:—*British Medical Journal*, 1916, Sept. 16.

The bacteriology of war gangrene is not yet on a satisfactory basis. In many cases a great variety of organisms are found; in others apparently a pure culture. *B. perfringens* and *B. oedematis maligni*, or organisms resembling these, are the most commonly found; but the variety of forms is surprising. Cultural methods fail to show this diversity. The organisms are not essentially *muscle feeders*; they grow in the lymph spaces of the endomysium. The variety is less in the clot with the greater number of leucocytes found there.

The status of the *toxin* production in war gangrene is still questionable. *Bull* and *Pritchett*:—*Journal of Experimental Medicine*, 1917, vol. 26, p. 118, have obtained a soluble toxin from *B. welchii*. *De Kruif*, *Adams* and *Ireland*:—*Journal of Infectious Diseases*, 1917, vol. 21, pp. 580-599, have tested the toxicogenic power of ten strains of *B. welchii* with the result that all the strains were found to produce toxin in greater or less degree and that an antitoxin produced by the injection of toxin from a single strain is capable of neutralizing all of the toxins. *De Kruif* and *Bollman*:—*Ibid*, conclude that the acidity of cultures of *B. welchii* is not the chief cause of their ability to produce experimental infections. The aggressin of the filtrate and toxin are identical. It appears to act by reason of its necrotic effect and not by a negative chemiotactic action on leucocytes. The

authors think that this throws light on the mechanism of the infection in the human body.

The problems of bacteriology, toxin and antitoxin production and pathology of acute bacillary gas gangrene have not yet reached a definite settlement. It is not rare in civil life; and the writer's autopsy material has furnished a number of cases showing great variety in symptomatology and pathology. In these cases organisms corresponding to the *Bac. oedematis maligni* were present in every case. The role of the mixture of bacilli, their relations to each other, and the individual action of each are questions needing solution.

The therapeutic use of *antitoxin* is still in an experimental stage. The most recent reports from the front seem to indicate a greater control of this infection by means of the new antiseptic surgical methods.

NOTE ON TRENCH FEVER.

A. S. WARTHIN.

One of the most interesting of the medical conditions associated with trench warfare is a relapsing fever first described as a distinct and characteristic malady, "*Trench Fever*" by *MacNee and Renshaw*:—*British Medical Journal*, February 12, 1916, and *Morichau-Beauchant*:—*Paris Médical*, Nov. 25, 1916.

After an incubation period of 5-22 days there is an initial chill, severe fatigue, intense headache and fever of 103.4° , which drops on the third day, rises at once, and falls again on the 6-8th day. Four days later there may be another relapse lasting a day or two, (the short form) or less frequently there may be many relapses, (long form). These two types, although other writers describe three forms, have been called A and B. In both forms there are frequent pains in the tibiae, the tongue is coated, there is great anorexia and constipation, but no diarrhoea. The spleen may be palpable. There is marked malaise and great prostration. The pains in the bones are characteristic and the most constant feature of the disease. They are most pronounced in the lower epiphyses of the femur and upper epiphyses of the tibia. They are most pronounced at night; are irregular in duration and may last over a period of several weeks. The fever, headache, fatigue and bone pains are the predominating symptoms according to practically all reports, but a great variety of other symptoms has been reported by various observers, but these are lacking in significance. There are no visceral symptoms

beyond an enlarged spleen; no chest symptoms except occasionally a complicating or preexisting bronchitis. The fall in temperature is marked by profuse sweating. Following the fall in temperature the patient is relieved, and apparently the attack is over; but from the 3-5th day he has a repetition of the symptoms; after this he may have other attacks, the intensity of the symptoms diminishing with each relapse to the end. After the attack there is a certain period of varying length in which the patient is very weak, and the pain in the limbs persists without disturbing the sleep. The separation of "trench shin" and "trench back" from trench fever is still unsettled. In many cases these conditions appear to be only symptom-forms of the latter.

The disease is said not to be atypical typhoid or paratyphoid, grippe, typhus or malaria. *Sherwood-Dunn*:—*Medical Record*, 1917, p. 155, believes it to be military fatigue aggravated by malaria.

The *etiology* is still unknown. According to the English authors the disease is transmissible by body lice taken from a patient suffering with the disease and placed upon a healthy person. It is also transmissible by inoculation of whole blood or washed corpuscles, the infective agent not being in the serum. No infective agent has as yet been positively demonstrated. The virus is not filterable. *Pappenheimer*:—*British Medical Journal*, October 13, 1917, reported the demonstration of a supposed characteristic organism in blood smears, sections of periosteum and fascia and in cultures from these tissues. Later (*Ibid*, Oct. 27, 1917) these bodies were shown to be artefacts and to have no etiological relationship to the disease. In the *Lancet*, Sept. 8, 1917, *Dimond* reported the finding of a "haemogregarine" in blood taken from cases of trench fever. *Henry*:—*Brit. Med. Journ.*, Dec. 1, 1917, concludes that Dimond mistook for the causative agent of trench fever a flagellate protozoan and a bacillus present in impure distilled water. No one, therefore, has as yet demonstrated the existence of a visible parasite as the causative agent of this disease.

The *prognosis* is good; cases always recover. The total course is usually four to six weeks. There are practically no complications. If it is true, as asserted by *Davies* and *Weldon* and others that the louse is the conveying agent of red blood cells containing the etiological agent, the *treatment* becomes essentially preventive. Otherwise, it is purely symptomatic.

The *pathology* is unknown. There have been few opportunities of studying tissue changes.

THE RELATIONSHIP OF FAT EMBOLISM TO TRAUMATIC SHOCK.

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In 1913 the writer published in the *International Clinics*, Vol. 4, S. 23, 57 pp., a very complete monograph on "Traumatic Lipaemia and Fatty Embolism." The material for this work had been put together in 1907 for publication in book form, but such publication had been deferred. The leading facts of the article, however, have been used in the author's teaching work for more than ten years, and were applied at the beginning of the War in special courses on War Pathology to the conditions resulting from bone fractures received in warfare. Therefore the recent publication by the *Atlantic Monthly Press* of William Townsend Porter's "wonderful discovery" that fat embolism of the pulmonary capillaries "is a frequent, if not the most frequent, cause of shock as seen on the battle-field" deserves a critical review because of the ignorance or the deliberate ignoring of the literature of American medical science shown in this *literary* article. The offense is the greater because the author of "Shock at the Front" makes it clear that his work was carried out, and evidently published, under the auspices of the Rockefeller Institute for Medical Research. Porter's discovery is revealed in paragraphs scattered through a *Atlantic Monthly* literary setting, as follows:

Page 44.—"The Surgeons at Compiegne had noticed that shock came on chiefly after wounds of the great bones, such as the thigh-bone, and after multiple wounds through the skin and subcutaneous fat, as from a shower of shell-fragments. These facts seemed very significant, although I little knew at the time that they would at length lead me to the discovery of the cause of shock."

Page 93.—"I could not rest, I was still pursued by the imperious fact that shock was most frequent after fractures and after multiple wounds through the subcutaneous fat. I took refuge in my laboratory, in experiment after experiment. The cause of shock was found, and a new remedy."

Page 95.—"Since the fracture of the bone is apparently a factor in shock, and since the absorption of a chemical substance was excluded, the mischief might be due to a mechanical agent. Now, the bone-marrow is very rich in fat, and it has long been known that after fractures of the femur large numbers of fat-globules appear in the blood, in which the globules circulate until they enter the capillaries in the brain and other organs. When a large fat-globule enters one of these small, hair-like vessels, it sticks fast, the blood can no longer flow through that capillary, and the cells supplied by that blood can no longer get food and oxygen.

"All this is well understood. For more than two centuries observations have been made by pathologists on changes in the tissues, following the injection of fat into the blood-vessels of animals.* Indeed a condition suggesting shock has incidentally been observed here and there in the course of these studies, although I did not know of these chance observations until long after my own experiments. No one, however, had declared or attempted to prove that the entrance of fat into the blood-vessels was the cause of shock as seen on the battle-field. The pathologists were after other game. They were interested in the anatomical changes in the tissues following the blocking of the capillaries. Since a falling blood-pressure is the out-standing symptom of shock, the proof demanded (1) that fat-globules should be injected into the vessels; (2) that the blood-pressure should be measured; (3) that the blood-pressure should fall gradually as it does in shock; (4) that the other symptoms seen in wounded soldiers should be accurately reproduced in the injected animal. The other symptoms are a feeble and rapid heart-beat, frequent and shallow respiration, pallor, low temperature, diminished sensibility and apparent unconsciousness.

"On February 2, 1917, the crucial experiment was made. An instrument for recording the blood-pressure in the carotid artery of an anaesthetized cat was arranged to write its record on a moving surface of smoked paper. When the normal pressure was in record, a little less than a teaspoonful of olive oil was injected into the jugular vein. Thereupon the blood-pressure began to fall, and the animal soon showed all the phenomena of shock observed in the wounded soldier.

"My attention was then directed to the discovery of a new remedy. Following the plugging of the capillaries by fat the arteries and heart are partially emptied, and the blood collects in the veins, especially in the large and numerous abdominal veins. In fact, the patient may be said to bleed to death in his own veins since the quantity of blood left in the arteries does not suffice for the nutrition of the cells of the brain and other organs."

Porter then proposes briefly remedies for the condition, such as changing the physical condition of the fat emboli, draining the blood from the veins by means of the respiratory pump, and finally the forcing of respiration by means of increased content

* As a matter of fact the history of lipaemia and fatty embolism begins with the experimental work of Magendie during the years 1821-36. The fact that Lower in 1669, and others later, made intravenous injections of large amounts of milk into dogs has sometimes been referred to as the beginning of the history of fat-embolism; but the tissue changes produced by such experimental work were first noted in a gross way by Magendie.—Editor.

of carbon dioxide in the inspired air; but without apparent great success for any one of these methods. He proceeds:

Page 135.—“Save a few wounds of the abdomen, in which the blood-vessels or their nerves in that great vascular region were probably directly injured, there has been no case of shock except after shell-fractures of the thigh, and after multiple wounds through the subcutaneous fat. In this closure of the capillaries by fat-globules is known to take place. This is strong support for my discovery that shock may be produced in animals by injecting fat into the veins.”

Page 150.—“I found an electrical method useful against shock in animals, but I have not yet succeeded in adopting this method for use upon man.

“In August, 1917, I sailed for my own country, bearing with me the certainty that fat embolism is a frequent, if not the most frequent, cause of shock as seen on the battle-field and the further certainty that the carbon-dioxide treatment is of advantage.”

This is Porter's most complete statement of his work, although in the *Boston Medical and Surgical Journal*, 1917, CLXXVI, page 248, he makes a brief assertion, without evidence, that fat embolism is a cause of shock. He further states that “Fat in the blood stream is not injurious *per se*; its injurious effects are the product of fat embolism.” See also *Comp. rend. Acad. d. Sc.*, 1917, 165, 164.

It is very apparent from Porter's book and article that he has no knowledge of the pathology of traumatic lipaemia and fatty embolism beyond the obstruction of the capillaries, the engorgement of the veins and the resulting arterial anaemia—all three of which conditions may, or may not, give a clinical picture resembling the phenomena of so-called surgical shock, and are frequently mistaken for such as had been sufficiently emphasized by the present writer in the monograph in the *International Clinics*. Porter does not distinguish between pulmonary fat embolism and localized fat embolism of the brain, heart, kidneys, adrenals, etc., or a disseminated fat embolism, and apparently does not know that there are distinct symptom-complexes of fatty embolism. He apparently does not know that fatty embolism when it reaches such a degree as to become clinically manifest in symptoms resembling those of shock and collapse is chiefly a *cerebral fatty embolism* and not a *pulmonary* condition alone, and that minute cerebral lesions, haemorrhages, infarctions, etc., have already occurred that cannot be remedied by respiratory pumps, carbon dioxide respiration, electrical treatment, etc. Further, there is almost always an increase of temperature in fatty embol-

ism and not a subnormal one as in shock. A knowledge of the pathology of the subject would have shown Porter that the treatment of fatty embolism is *preventive* and not *curative*.

The writer's article in the *International Clinics* was written in 1907 for the express purpose of showing surgeons the surgical frequency and importance of fatty embolism, and the fact that it was usually mistaken for surgical shock and collapse, and that it had a specific pathologic and clinical entity of its own, with characteristic diagnostic signs—one of these, the presence of fat droplets in the sputum, was for the first time shown to be the earliest diagnostic sign of pulmonary fatty embolism. Without quoting too freely from this article a few particularly significant paragraphs are reproduced here:—

Page 3.—"Fatal cases of fatty embolism from the common accidents of our large cities are every day diagnosed as "shock, coma, apoplexy, alcoholism, concussion, 'had heart', etc."

Page 4.—"Without warning and without apparent cause (after fractures or amputations), a state of restlessness with mental anxiety, disturbance of heart and respiration, delirium and coma, sets in, and death may take place within twelve to twenty-four hours. In explanation and justification of these fatal cases, the surgeon frequently takes refuge behind a diagnosis of shock or concussion. It is extremely probable that the majority of these cases are the results of traumatic lipaemia and fatty embolism, and it is highly desirable that more attention be paid to the differential diagnosis of fatty embolism, shock, concussion, diabetic coma, lymphatic struma, alcoholism, etc."

Only one case out of thirteen of fatal fatty embolism autopsied by the writer had been correctly diagnosed clinically, and in this case, the diagnosis had been made by a laboratory assistant who had heard discussions of the condition in the pathological laboratory. "Shock, heart-failure, acute cardiac dilatation, cerebral haemorrhage, pneumonia, sepsis, insanity and alcoholism were the clinical diagnoses for the other cases, and the true cause of the symptoms remained unsuspected."

Page 19.—" * * * deaths following fractures and amputations are probably often reported as the result of shock, 'heart-failure,' concussion, haemorrhage, pneumonia, sepsis, etc., when the real cause is fatty embolism. This has been the actual pathological experience of the writer, and must be true of medical practice in general."

In his review of the literature and in the descriptions of his own cases the writer has pointed out the varying symptomatology of fatty embolism, with the predominating low arterial pressure,

venous congestion, symptoms of collapse, Cheyne—Stokes syndrome, etc., that so often give a clinical picture interpreted as shock. Series of animal experiments on hares, dogs and chickens were carried out showing the symptomatology and general pathology of fatty embolism in these animals to be similar to that in man. Synchronous tracings of carotid, auricular and jugular pressures were made, and frequently demonstrated to students in experimental pathology, showing the rapid fall of carotid pressure and steady increase of auricular and jugular pressures terminating in delirium cordis and death, as the result of the injection of oil directly into the jugular vein or heart.

Fatty embolism may be produced by all varieties of bone—injuries involving the fatty marrow, fractures, surgical operations, concussion, osteomyelitis, haemorrhages, presence of foreign-body, neoplasm, etc. By far the most common cause is fracture, and especially comminuted fractures; much less common is fatty embolism after injury to adipose tissue, bruises, wounds, burns, operations, childbirth, etc. Still more rarely is it associated with rupture of fatty liver, and lipaemia associated with poisons or diabetes as a cause of fatty embolism is very rare. The wounds of war causing fractures of large bones like the femur, tibia, etc., with the marked comminution and injury to the marrow associated with such wounds are *precisely the type of wounds with which we should expect fatty embolism to be associated. It undoubtedly is one of the most important surgical conditions of the present war.*

But is it shock? Both Bissell (Surgery, Gynecology and Obstetrics, July, 1917, p. 8) and Porter have utterly failed to see the point of the writer's monograph in the International Clinics. The object of that article was not to prove the identity of surgical shock and fatty embolism, but to show that surgeons most frequently mistake fatty embolism for shock, or something else, instead of making a correct diagnosis of the former condition. Fatty embolism is a distinct clinical and pathological entity. It should not be mistaken for shock. Its occurrence should be anticipated in all injuries to bones containing fatty marrow. Its therapy will be preventive rather than curative.

For a full discussion of the symptomatology and pathology of fatty embolism the reader is referred to the writer's monograph in *International Clinics*, 1913, D, p. 171.

Addendum. Since the above was written *Wiggers: Proceedings of Soc. for Exp. Biol. and Med. Soc.*, Dec. 19, 1917, has published a brief note on Fat Emboli and Shock, in which he

shows that the circulatory failure produced by fat emboli should be distinguished, for academic as well as for therapeutic reasons, from that due to surgical shock. His experimental work shows that neither the intravenous nor the intra-arterial injection of fat produces changes in the dynamics of the entire circulation comparable to those found in shock following exposure of the intestine. He, therefore, concludes that "the hypothesis that fatty emboli, either of the pulmonary or systematic vessels, is the cause of circulatory failure in surgical or traumatic shock is not corroborated by our experiments." This conclusion is, therefore, in harmony with my attempts to put fatty embolism on its own feet as a surgical entity distinct from shock.

As this proof is being read *Simond's* article in the *Jour. of Exper. Med.*, May 1, 1918, has just come to hand. This contains another example of the gross mis-reading of articles, in that Simond says that Warthin, Bissell and Porter are convinced that fat embolism is "a cause" of surgical shock. As my article was written with a different view of the case, I fail to see how such a statement concerning it can in any way be obtained from it.

DEPARTMENT OF EXCHANGES

CONDITIONS OF EXCHANGE

1. The exchange is transacted directly between the giver and recipient. Before any material is sent out to any applicant he must be notified of his intention by the proposed donor, in case the request has already been granted by some other member of the Association.

2. The cost of transportation is paid by the institution receiving the material transported.

3. If the specimens are very small, they may be sent by post. Large specimens should be transported, not in individual glass jars but in bulk, wrapped in moist absorbent cotton, and packed in soldered tin or other water-tight receptacle.

4. Each specimen should be tagged with its reference number, written in India ink on tape (preferably paraffined). A statement of the nature of the specimen and, where possible, a brief history of the case bearing the reference number should be forwarded to the recipient.

MATERIAL REQUESTED IN EXCHANGE.

A special request for material showing the diseases and injuries of war has been received from *Prof. A. S. Warthin, Department of Pathology, University of Michigan, Ann Arbor, Mich.*, to illustrate the summer courses of lectures given upon War Pathology at the above Institution. Any members having access to any of the conditions requested will confer a favour upon this Department by forwarding it to Dr. Warthin at the above address.

The list of conditions requested is as follows:—

1. *Pathology of Camp and Trench Infections*: Typhus, Typhoid, Gastroenteritis, Dysentery, Cholera, "Trench Kidney", "Enlarged Abdomen", Pulmonary Distomiasis, Tuberculosis, Venereal Diseases, Skin Parasitic Affections, etc.
2. *Pathology of Hospital Infections*: Tetanus, Gangrene, Gas-Gangrene, Phlegmon, Erysipelas, Post-operative Infections, Post-operative Pneumonia, Trench Icterus, etc.

3. *Pathology of Trauma*: Wounds, Burns, Electrical Injuries, Fat-Embolism, Concussion, Shock, Effects upon Ears, Aviation Affections, Nervous Lesions, War Neuroses, Effects of "Gassing", Fumes from Various Explosives, Gasoline, Exhaust Gases, Battery Fumes, etc., Sunstroke, Heat Exhaustion, "Chilblains", Effects of Cold, Standing in Water, etc., Accumulated Fatigue.
4. *Pathology of Repair*: Healing of Wounds, Fractures, Plastic Operations, Transplantations, Grafting, etc., Effects of New Antiseptic Methods, etc.
5. *Pathology of Military Occupations*: Munition Workers' Diseases; etc.

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CONSTITUTION AND BY-LAWS OF THE INTERNATIONAL
ASSOCIATION OF MEDICAL MUSEUMS.
AMENDED AUGUST 6, 1913.

ARTICLE I.—NAME AND OBJECTS.

This Association shall be called The International Association of Medical Museums. It shall have as its objects:

1. The promotion in a general way of the efficiency of the Medical Museum as a compendium of scientific facts, a store-house of material for, and of the results of research, and as a medium for teaching.
2. Discussion of plans of cataloguing and classification, and methods for the preparation and preservation of specimens.
3. Arrangements for the interchange of specimens and for the specialization of certain museums along particular lines in which they may enjoy the best facilities.
4. The publication of a Medical Museum Bulletin, which shall aim at the furtherance of the above objects.
5. The consideration of the feasibility of establishing an Index Pathologicus in the future.
6. The establishment of central bureaus in various countries for the preservation of the results of original research and for the exchange of material.

ARTICLE II.—INTERNATIONAL MEMBERSHIP.

The membership shall be elective, and shall be international in scope, including representatives of the leading medical museums throughout the world.

All persons actively engaged in, or interested in, the work of medical museums may become active members on election and the payment of \$2 per annum.

Members may be elected at the International meetings or in the interim of the meetings, by the local Section of that country to which they belong.

Only those persons officially accredited to a medical museum as its representative may vote.

Persons distinguished for eminent services to science and especially to the cause of museums and of this Association, may be made honorary members.

ARTICLE III.—INTERNATIONAL FEES.

There shall be an admission fee of \$2, payable by active members immediately on their election, and an annual fee of \$2, payable in advance on January 1st of each year, and falling due the year after election.

ARTICLE IV.—INTERNATIONAL OFFICERS.

The International Officers shall be a President, three Vice-Presidents, a Secretary-Treasurer, and as many Councillors as there are countries represented in the Association, one Councillor for each country; these Officers shall together constitute an executive committee. They shall be elected triennially at the international meeting for the ensuing triennium and for the next international meeting, except the Secretary, whose position shall be permanent. The President shall, whenever possible, be elected from that country where the next international meeting will be held.

ARTICLE V.—OF THE SECTIONAL SOCIETIES.

1. There shall be a central international body with international officers, and local or sectional societies with local officers, one society in each country represented.

2. The officers of the local societies may be elected annually or triennially, and shall consist of a president and secretary, and as many other officers as the local society shall decide. The officers of the International Association shall be as provided under the present constitution.

3. A local fee may be arranged at the discretion and option of the local society, but the international fee shall remain \$2 (two dollars). It shall continue to be paid to the international secretary, and shall be devoted to the cost of the bulletin, the payment of international postage, and other international outlay.

4. The meetings of both the International Association and also of the sectional societies shall be reported in the bulletin, and all communications presented at all such meetings shall be available for publication in the bulletin. This will not preclude their publication elsewhere as well, nor is the editorial committee pledged to publish all papers presented at either the international or sectional meetings.

ARTICLE VI.—MEETINGS.

The meetings of the international body shall be held at the same place and time as the meetings of the International Congress of Medicine. The meetings of the sectional societies shall be held annually or more frequently, according to the decision of the individual society.

ARTICLE VII.—TRANSACTION OF BUSINESS.

All matters of general policy and interest shall be decided by a two-thirds majority vote of all the voting representatives present at a stated meeting. At such meetings nine members shall constitute a quorum.

The vote may be taken in the interim of the meetings by the Secretary by means of correspondence, and the matter submitted shall then be decided by the two-thirds majority vote of those voting.

Together with each stated meeting there shall be a session of the Executive Committee for the transaction of business. At such meetings four members shall constitute a quorum.

ARTICLE VIII.—CHANGES IN THE CONSTITUTION.

Amendments to the Constitution shall be decided by the two-thirds majority vote of the active members. Such measures to be proposed in writing to the Secretary, who shall submit them to the Executive Committee, and through these to the Association, either at the regular meeting or in the interim by means of correspondence.

BY-LAWS.

I.—DUTIES OF OFFICERS.

The President, Vice-President and Secretary-Treasurer shall discharge the duties usually assigned to these offices. The Secretary-Treasurer shall, in addition to these duties, call for and receive the written votes of all the voting representatives in all matters to be decided by correspondence in the interim between the regular meetings, and shall secure papers and addresses for the regular meetings and arrange the program therefor.

II.—THE EDITORIAL COMMITTEE.

A Committee on Publication, including the President and Secretary, *ex officio*, and three or more other members, shall be appointed every three years, who shall have as their duty the periodical publication of a Museum Bulletin.

III.—CHANGES IN BY-LAWS.

A By-Law may be amended by the two-thirds majority vote of the voting representatives, one month after the written notice of the proposed amendment has been received in writing.

ADDENDUM

WATCH-GLASS MOUNTING FOR MUSEUM SPECIMENS, WITH ELATERITE SEALING.*

J. J. MACKENZIE, Professor of Pathology.
University of Toronto.

We have not only found it difficult sometimes to present the salient features of a gross pathological specimen in the ordinary jars used for that purpose but have found them also bulky and awkward to handle in the class-room for demonstration purposes.

To obviate these objections, and for economical reasons, we have adopted the watch-glass method of mounting, as described by Day of Chicago, and others, with some modifications, as follows:—

Deep watch-glasses from four to six inches in diameter are chiefly used. The edges are ground down to form a good flat surface all the way around on a sheet of plate glass with carborundum powder and water.

The specimen, after being properly fixed in 1st Kaiserling and color brought back in alcohol, is left a day or so in 2nd Kaiserling. It is then trimmed down to fit the watch glass. The specimen is set in the glass concave side up and No. II Kaiserling, which has previously been heated to boiling point, and colored to remove the air, is poured in. A square piece of plate glass cut and edges ground to be one-half inch wider on each side is then slipped over the watch-glass. If any bubbles appear, slip the glass back slightly over the edge and pour in more Kaiserling. We then usually allow the specimen to stand a day or two to make sure no more bubbles will form. The edge around the watch-glass is then thoroughly dried and a coat of Elaterite* is applied. This has the consistency of thick syrup and may be painted on with a small brush. It dries quite readily, being firm and fairly elastic, and will not melt when exposed to direct sunlight. Additional coats of Elaterite are painted on until the sealing is quite safe.

* Received too late for publication in the Proceedings of the Association on page 81.

* May be procured from Bausch & Lomb.

BULLETIN NO. VIII

OF THE

International Association of Medical Museums

AND

Journal of Technical Methods

Sir William Osler Memorial Number

PART I

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DECEMBER, 1922

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Möller

SIR WILLIAM OSLER, BART., M.D., F.R.S.

(1849-1919)

From his youth an enthusiastic student and research worker in the field of pathological anatomy, a past master in the technique of the postmortem room and an ardent exponent of the Museum idea, the late Sir William Osler was ever a warm and understanding friend of this Association. As one of its Charter Members and an International Councillor since its inception in 1907, his sympathy and active interest were with us always, and to his timely support and counsel in the early years of its organization the International Association of Medical Museums owes much of its present status. As mentioned editorially, Bulletins No. VIII and IX are being issued as Special Memorial Numbers. A full biographical statement will be found in Bulletin No. IX. It suffices here to recall the fact that the span of his life was divided, in almost equal periods, among the three countries that may be said to have lain closest to his heart,—though it is to be remembered that his affection and his interest extended beyond these, embracing the whole fellowship of man. *Canada*, the land of his birth and early professional life, gave him those youthful cultural influences in the environment of a happy home, and that wealth of biological and pathological experiences that became as the foundation stones of his career. *The United States of America*, his abode through twenty years of his manhood's prime, received him with acute perception and complete appreciation of his genius, and gave him, in the congenial fellowship and immense resources of the great schools of Philadelphia and Baltimore, that vantage-ground from which he rose to the level of a great clinical teacher and a vitalizing and constructive force in medical education throughout the world. Last, but not least, *England*, the home-land of his parents' hearts, the seat of that early culture and the storehouse of that classic literature he loved so well, called him to herself and crowned him, in the afternoon

SIR WILLIAM OSLER (1849-1919)

of his life, with the highest honours in her power to bestow, the Regius Professorship of Medicine in Oxford University and the Presidency of the British Classical Association. And to England he in turn brought, in fullest measure, his best gifts. Here, in the quiet days of peace, his native bibliographic skill and wide erudition came into their own in the quiet recesses of the Bodleian Library and the resources of the Clarendon Press; his gospel of the co-ordination of clinical and pathological knowledge and his faculty of infusing wide human interest resulted in the reorganization of medical teaching at the Radcliffe Infirmary and the rejuvenation of the activities of his own office of Regius Professor; then, throughout the years of the great War, all his powers of co-ordination, all his faculty for the guidance and inspiration of others, all his own capacity of self-devotion and personal sacrifice, were poured out in richest measure, for England's need. The full extent of what he accomplished for England and her Allies in those years of Europe's cataclysm we do not, and may never, know; but we realize that his service was very great, if measured only by his ceaseless productivity for the good of others in the years that went before.

Still in the zenith of his powers, with the tale of his life-work but half told, in the midst of extensive plans for the expansion of post-graduate work in England, and the amelioration of post-war conditions, he died, on December 29th, 1919, to the lasting sorrow of his many friends and the profound regret of his associates in the medical profession throughout the world. In his passing, humanity at large has lost a sympathetic, understanding and productive soul, but his spirit lives among us in an undying tradition of devotion to the service of others and to the cause of scientific truth, and finds its best expression in the great *Bibliotheca Prima* of his final bequest.

MAUDE E. ABBOTT
LAWRENCE J. RHEA

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AND
Journal of Technical Methods

Sir William Osler Memorial Number

PART I
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EDITORIALS

THE SIR WILLIAM OSLER MEMORIAL NUMBERS

The appearance of this Bulletin under a new and more pretentious title, *Bulletin of the International Association of Medical Museums and Journal of Technical Methods*, with a Table of Contents that must be considered to present an important contribution to the field of Morphological Research, may, we hope, serve to compensate for the unavoidable delay that has occurred since the appearance of Bulletin VII. This delay has been the source of much regret to the Editorial Board, for, while our Constitution provides only "that a Bulletin be issued from time to time as material accumulates" without specifying the time interval, it is the intention of the Association that this Bulletin shall provide at least a yearly channel of publication for the communications of our members on anatomical and pathological technique and morbid anatomy presented at the annual meetings and elsewhere. To those contributors whose

papers have been held over for an unduly long period, it may be said in explanation that the primary cause of this delay has been lack of funds, due, in the first place, to the heavy expenses of the Atlantic City meeting in the year 1919, combined with the high cost of printing at that time. Then came the deeply-regretted death of the late Sir William Osler on December 29th. 1919, and the Resolution passed at the Cornell Meeting of the American and Canadian Section in April, 1920, that the next Bulletin of this Association be published as a special Sir William Osler Memorial Number. This decision involved further waiting, until such time as material of sufficient value could be obtained to constitute a worthy memorial, and until the required funds for its publication might be raised. The articles sought were of two kinds: (a) Communications of a personal or biographical character upon the early cultural influences and scientific researches of the late Sir William Osler; and (b) contributions of a technical and scientific character, which should serve to lift this Bulletin into the place which it is qualified to fill, as the organ of an Association that has become a recognized medium on this Continent for the communication of technical procedures in medical teaching and research, and which is coming yearly more and more into evidence as a fostering influence in the conservation and elevation of that study of pure morphology that lies at the root of scientific truth.

In response to the call for such contributions a rich material gradually accumulated which finally assumed a bulk so large that it became impossible to publish under one cover all the special memorial articles, together with those from the meetings of the Association. It was, therefore, decided by the Editorial Board to issue two Bulletins, one immediately succeeding the other, of which one should contain all the personal and biographical articles, and should appear as a special Sir William Osler Memorial Number, to form Bulletin IX of the Association (which is now in the press), and the other volume to constitute Bulletin No. VIII, and to contain all the technical and scientific articles, together with special Retrospects of recent literature on microscopic and macroscopic technique, prepared by authorities in these respective fields. For these Retrospects, which appear on pages 53 and 105, we are deeply indebted to Prof. F. B. Mallory and Dr. C. F. Silvester, who have prepared them expressly for this

issue, with a view to bringing it to a completeness which will justify the cognomen *Journal of Technical Methods*, under which it is hoped that the Bulletins of this Association may long continue to serve the cause of scientific medicine in the various countries where our membership lies. A department of Abstracts of Current Literature on Microscopic and Museum Technique and Arrangement has also been introduced, to meet the lack of segregation of this subject which exists in the Medical Index periodicals of this continent, and which is felt by our Council to be an actual need.

Thanks are also expressed to the National Research Council of Washington, Sir Edmund Osler and the Hon. Mr. Justice Featherstone Osler, of Toronto, Mrs. K. S. Reford, and the late Mr. R. B. Angus, of Montreal, Mr. J. J. Carty, of New York, and a number of other friends of Sir William Osler for the generous subscription of funds, with the help of which the cost of publication of these two Memorial Bulletins has been defrayed.

THE STUDY OF MORPHOLOGY THE FIELD OF WORK OF THIS ASSOCIATION

The following series of papers deal partly with problems of morphology, partly with the technique of morphological investigation. This seems peculiarly fitting as a memorial to Sir William Osler. For no one had a greater appreciation of the importance of morphological research and teaching in relation to Medicine than he. He emphasized it throughout his long career, by speech and writing. Its renewed value is amply demonstrated by the great revival in morphological investigation during the last twenty years, and the still growing importance which it occupies in the future of Medical Science. For function and structure are in such intimate contact and the former so dependent on the latter that full knowledge of the activity of any organ is impossible without, at least, a visual conception of the underlying structural basis.

In this field this Association and its Bulletins may occupy and fill an important position, for its main purpose is to keep fluid those technical means and sources which lead on to a profound knowledge of structure.

THE EXCHANGE OF MUSEUM SPECIMENS

The members of the American and Canadian Section of the International Association of Medical Museums are at present dependent upon personal solicitation between other members and other faculties for an exchange of pathological material, and many of us, particularly those engaged in teaching pathology (most of our members), occasionally find ourselves without representative tissues for certain diseases, even for microscopical work. It has, therefore, become increasingly apparent that some central exchange for such material should be established with a view to securing the maximum of variety throughout all our medical schools. The idea has been talked of by many of the members of the Association, and ways and means have been considered for its establishment. With the limited funds at our disposal, and practically all the centralized activities now located at McGill University, the only possible way of conducting such an exchange has been by adding to the duties of our Secretary-Treasurer who, as we all realize, has been much overburdened for some time past, but who has gladly accepted these increased responsibilities. It therefore seemed desirable to consider the establishment of such an exchange at some other place, possibly more centrally located so far as the laboratories of the majority of members of this Association is concerned. The impetus to the effort was given by a letter from Professor Jas. W. Jobling, of New York, who suggested to the office of the Surgeon-General of the Army that the proper location for such an exchange was at the Army Medical Museum, Washington, D.C. This met with the hearty support of the Surgeon-General, who requested permission to grant space for the establishment of such an exchange at the Army Medical Museum. The Secretary of War has authorized the issue of a revocable lease to the Association, and the Surgeon-General will authorize the medical officers of the Army on duty thereat to care for the administrative details of the exchange in so far as they require the services of a pathologist.

The Army Medical Museum has considerable surplus material, but unfortunately most of it is preserved in alcohol. The value of this material is a matter for conjecture and can not be decided until further work is done with it and the staining reactions of this tissue investigated.

Consideration was given this project at the meeting of the Association held at Washington, May 1st, 1922. It was there decided that the central bureau for the preservation of results of medical research and the exchange for pathological specimens should be transferred from McGill University to the Army Medical Museum. It is the intention as soon as sufficient amount of material can be placed in the available duplicates for exchange, to send out a notice to the Association members stating the kind of material and quantity available, and to invite contributions of specimens to the exchange. At the same time, any requests which may come in which can not be filled by exchange of material on hand, will be placed in this notice with the idea that any of the members having surplus material of the kind desired will communicate directly with those requesting it, or, if they prefer, can send the material to the Army Medical Museum where the exchange can be arranged. Transportation of material to the Museum can be covered by frank up to the amount of 4 lbs., and similarly on material sent out from the Museum. Gross specimens which, when packed, will weigh more than 4 lbs. can be sent to the Army Medical Museum at government expense, provided the specimen is acceptable to the Curator and arrangements must be made with him for such shipments. Specimens being sent out from the Army Medical Museum will be franked where the weight is less than 4 lbs., but will be sent at the expense of the receiver if anything over that amount. The exchange will develop slowly as the personnel at the Museum can assign but a small proportion of their time to the work, but it is not believed that any great demand will be made upon it immediately. Until the first notice is sent out there will be no material available for exchange.

The central bureau for the preservation of the results of medical research will have a permanent file of records entirely independent from those of the Museum as a whole, and separate cabinets for slides and cases for specimens representing the result of original research. It will be kept carefully under suitable safeguards to prevent loss and will be open for consultation under adequate supervision to those qualified to consult it. Contributions to this section are solicited, such material to be representative of the work done in research so that a permanent record of tangible evidence may be placed in a central location under proper care and permanently preserved.

G. R. CALLENDER.

ORIGINAL COMMUNICATIONS

General Articles

THE COMMON INTEREST OF ALL MUSEUMS, IRRESPECTIVE OF THEIR COLLECTION*

PAUL M. REA

*President of the American Association of National Museums,
Cleveland, Ohio*

Ladies and gentlemen, after a pleasant and profitable correspondence with your Secretary, extending over a number of years, I particularly appreciate this opportunity of extending to your Association in person the greetings of the American Association of Museums. At her request it is my privilege to say a few words to you this morning on the subject of the common interest of all museums.

We have had in America a hundred and forty eight years of experience in museum evolution. During this period certain types of museums have been developed to meet the peculiar needs of the times and in many instances these museums have finished their work and relapsed more or less into a state of inactivity. During the past twenty-five years we have seen the evolution of a new and broader type of museum, which for lack of a better term may be called the public museum. Institutions of this type are typically supported by a combination of private funds, devoted to the creation of collections and the conduct of the scientific work, and of public funds provided for the maintenance and operating expenses of the plant. The essential idea of these museums is their recognition of the broad function of interpreting science to the people at large. In the performance of this function I believe they have already proved how great an opportunity they have of contributing in a large way both to the progress of

*Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

science and to the betterment of our social structure and practice. It is with this type of museum that my interests are chiefly identified and I have recently had the interesting experience of coming from the oldest museum in the new world—that of Charleston, South Carolina, founded in 1773—to the youngest museum—The Cleveland Museum of Natural History, whose articles of incorporation were filed only in the middle of December, 1920, and which still has before it the task of creating from the very beginning its collections, its organization, and its policies.

These public museums with their broad functions are probably still in the infancy of their development. They deserve the active interest and support of all who are interested either in the progress of science or in the enrichment of the life of the people. These museums, however, do not conflict in any way with the many special types of museums conceived and operated for particular interests and purposes. Among these special types are the medical museums, performing in a narrower professional field the same function of interpreting science to medical students and practitioners. The relationship of such special museums to the general public museums is the theme to which I would invite your attention this morning.

It seems to me that it is most desirable that we should accustom ourselves to consider this relation in such broad terms that we may appreciate fully the community of interest and of problems that these institutions possess, and carefully avoid the error of thinking that the differences in purpose and in methods set these two classes of museums so far apart as to be of little interest to one another.

If I am not mistaken, the essential idea of the museum, apart from its function in the preservation of the data of science, is the interpretation of ideas associated with the objects in our collections. Museums appeal to the quickest and most vivid sense organ we possess—the eye. They are, therefore, institutions of visual instruction. The principles of visual instruction are essentially the same whatever may be the nature of our material, whether of art or history or science; whether our appeal is directed to the general public or to a selected group. We, therefore, have in common a fundamental problem of presentation. This problem involves not only technique, but sound psychology, and it will be helpful to us to appreciate the similarity of this problem to that of the commercial advertiser, whose task, equally with ours, is to arrest attention and impress ideas. The fact that medical students may be compelled to observe your material does not make it any the less important that you arouse the warm interest

of these students than it is for the public museum to arouse the similar interest of people in general. To the solution of this problem both groups may contribute. Perhaps the greater fertility of ideas will be found among the public museums.

In the development of technical methods we surely have a common problem, and to the solution of this the special museums may well be expected to contribute a major share. When Mr. Miner, of the American Museum in New York, participated in your conventions as a representative of the American Association of Museums, I know that he obtained profitable suggestions from you, and I hope that he contributed ideas of value to you.

As the evolution of museums proceeds we may confidently expect that we shall find less desirable a somewhat sharper definition of the scope of various types of museums, and it is important that we have a sufficient knowledge of each other's theory and practice to enable us to make these different types of museums complementary, avoiding such duplication of effort as may be unnecessary, and supplementing each other's work effectively. There is already ground for confidence that we may hope to effect in the near future a cooperation between different kinds of museums that will lead to cross-references between museums of art and history and science, and between general public museums and special museums. That such a development is desirable I think none of us will question. I also think it is obvious that it can be worked out only when we have a broad knowledge of each other's work and sympathy with each other's purposes.

I look forward confidently to the time when the value of museums will be appreciated far better than it is to-day, and when appropriate types of museum service may be made available to practically all people instead of being confined to those of exceptionally fortunate cities and institutions of learning. If the suggestions I have made to you so briefly lead in any degree to an increased spirit of helpful and sympathetic co-operation, they will have contributed to the common cause in which we are enlisted.

THE POSITION OF MORPHOLOGY IN MODERN
PATHOLOGICAL RESEARCH

HORST OERTEL

I

Every important epoch in medicine has been ushered in by, and rests directly upon important anatomical discoveries.

Thus, the anatomical observations of the Alexandrian School, based for the first time on man himself, inaugurated the system of Galenus; thus also, the reformation of medicine in the middle ages came through the investigations of Vesalius, and the modern ideas of disease rest on the principles of general anatomy as founded by Bichât and Henle, and the cell doctrine of Schwann and Virchow.

Every refinement in the ideas of function has inevitably been preceded by, and is necessarily dependent upon, refinement in knowledge of anatomical structure. Where structural knowledge is lacking or impossible—as in the present day methods of research and reasoning into the phenomena of immunity—ideas remain, in spite of all efforts and a multitude of observations, hazy, uncertain, even fantastic; often, by tacit acceptance of hypothetical conceptions as facts, misleading in their significance, practical application, and influence on future research. Thus, the title of the first great work in modern pathology, Morgagni's "*De sedibus et causis morborum per anatomen indagatis*," expresses it in simple greatness, "On the Seat and Causes of Diseases *studied through Anatomy*." For here we have the first systematic attempt to localize diseases and explain them through their anatomical changes. In recognition of this fact, Rokitansky used this title in somewhat modified form for the inscription on the pathological institute in Vienna: *Sedibus et causis morborum per anatomen indagandis*.

II

A curious belief grew and spread during the last decade of the 19th century and the beginning of the present, that the limit of discoveries in morphological research had been reached and this idea was even shared by many investigators. It is an impression which has occasionally appeared during the history of biological sciences. Thus, in the preface to his excellent translation of Stöhr's Histology, Lewis mentions that in 1821 when Charles Bell announced his great discoveries concerning nerves,

he stated that scientists had often remarked to him—"In your department we can hope for nothing new. After so many eminent men in succession of ages have laboured in your subject, no further discovery can be expected," and an American professor of anatomy, forty years later, described his science as "a well reaped field." And yet, shortly afterwards the islands of Langerhans were discovered in the pancreas, a discovery which had the greatest influence on the ideas of the functions of the pancreas—no matter how we interpret the morphological position and significance of the islands at the present day.

Thus also nearly twenty years ago a colleague expressed it to me as regards pathology: "Medicine can no longer profit by morphological investigations in pathology except in details."

Is pathological morphology really a finished product? Is it, properly catalogued and labelled, to be put on the shelf for reference? Its recent history does not answer these questions in the affirmative, for, since the beginning of this century, morphology has once more taken a leading part in pathological science, and it has once more been demonstrated that a better understanding of function is best reached through a refined knowledge of structure.

This revival in pathological morphology has been made possible, first, by an extension of its field of investigation from that of cells and tissues to that of whole organs and systems; secondly, by the application of the principles of colloidal and physical chemistry and of physics to the study of cell structure and activity; thirdly, by the growing importance of morphological evidence in relation to infection and immunity.

III

The fact that an accurate, adequate, idea of the functions of an organ rests upon a clear conception of its architecture has long been recognized and prosecuted by anatomists and physiologists. Thus, for example, Bowman based his views on the secretion of urine practically entirely on the structural arrangement of the kidney, and these views stand to-day, in their main points, correct.

But pathologists, up to the beginning of the present century, had curiously neglected this important line of research—I take it largely for technical reasons—and confined themselves to the study and elucidation of pathological problems through investigations of tissue changes and histogenesis. True, there were isolated instances in which observers endeavoured to go beyond this, but they remained incomplete and were not elevated to the dignity of a general method of research.

It has become increasingly plain however, that in disease, as in health, the study of cells and tissues is insufficient unless it is extended to include their union and arrangement into an organ. That is to say, the investigation of pathological lesions should not end with, and confine itself to, study of cell and tissue changes, but it must construe the whole plan of the pathological organ which results from such cell and tissue changes.

When Kent and His showed, as regards cardiac function, that not any of the heart's muscle tissue, but that of a particular muscle bundle is of first importance, that this is concerned with the conduction of impulses, pursues a definite course in the organ and must, therefore, be considered in its complete architectural relations to the rest of the heart, they not only shed a flood of new light on the normal and abnormal functions of the heart, but demonstrated the necessity of recognizing the construction of an organ as a whole in its relation to pathological function. For, although the heart is an apparently simple muscular organ, its functions are dependent upon the anatomical relations which certain muscle bundles have to others. And, as Keith has shown, this whole arrangement becomes intelligible on the developmental morphological basis.

Thus, the morphological investigations of the last twenty-five years have revolutionized our knowledge of heart physiology and pathology, and have opened new lines for thought and research regarding similar automatic action elsewhere, as, for example, in the gut.

But an even larger, more general field has developed for pathological morphology through the modern, more perfect methods of organ reconstruction by injection of the vascular tree. The importance of the circulatory arrangement in relation to the functions of an organ is evident and has been well recognized by physiologists. In normal anatomy and physiology the reconstruction of the circulation has, therefore, been in the past an important and well recognized part of investigation. But up to five or six years ago very little of this was practised in pathology. Its importance was only partly recognized and the technical difficulties were too great for general usage. What could be obtained with reconstructions by serial sections remained very limited for it was not only very time-consuming but, especially in pathological organs, imperfect and often unreliable. Even the introduction of the X-rays was for some time of little avail, as the difficulties of perfect injection of whole organs, while obtainable in individual cases, prevented a more general application and the collection of a sufficient material for the solution of important

problems. Thus, even the standard books on pathological technique barely mentioned anything about organ reconstruction. For example, one, published in 1907, stated that "the artificial injection of blood and lymph vessels does not play the role in pathological histology as in the normal", and as late as 1915, we find, in another standard book on pathological technique, this statement, "Injections are not much used in pathology. The process is an art that requires much patience and considerable experience."

Here the method of Gross, introduced within the last few years, has already been productive of much advance. A relatively simple procedure, it obtains for us a clear cut, reliable injection of the complete circulatory or duct system of a whole organ which, especially when stereoscopically observed or through later clearing of the whole organ in oil of wintergreen, shows a plastic picture of a whole circulatory arrangement. It thus furnishes an excellent and rapid method of demonstrating the reconstruction of organs under pathological conditions. It has already given us clearer and newer conceptions of the anatomy and functional disturbances in the inflammations of the kidney, lung, heart and liver through a complete visualization of architectural construction. It promises still more for the future.

There is another field of pathological morphology which has received more adequate attention recently and assumed a growing importance in regard to physiological and pathological life.

It deals with the evolutionary changes during the various age periods of an individual and their relations to normal and abnormal functions. We may safely say to-day that what appears to us as a man's age, or what we speak of as ageing in a person, are conceptions which are based on external appearances of a combination or sum total of definite, orderly sequences in anatomical changes in the construction of organs and consequently in their relations. While these anatomical changes are responsible for the differences of one physiological age period from another, they also throw light on many questions in pathology, notably differences in predisposition to diseases, immunity, (both of which vary with age periods) and other obscure pathological changes in organs which are plainly not "infective," but rest upon disturbances of the internal forces of organization. For the older idea that the body, once it has reached maturity, remains more or less fixed and stable, can no longer be maintained since we are acquainted with the morphological fluidity of all individual organization. This fluidity is, so it appears, of two types; first, a general one, incident to and representative of, an age period; secondly,

organic and specific and represented by constant cell and tissue regression and progression. In regard to these latter phenomena, present evidence makes it probable that each organ possesses its own specific rate and quality of changes. It need here only be pointed out how interferences with, or lack of balance, or perversity in these activities, are followed by abnormal morphological changes and hence disease.

IV

If the advances and possibilities for future progress considered in the last paragraph depend upon an extension of the domain of morphological research, the second line of advance has been made possible by the application of the principles and methods of modern colloidal and physical chemistry and of physics to morphological cell problems. These sciences have extended and reshaped our conceptions of the structure of cell protoplasm. They have enabled us to reach more exact reasoning of its inter-relations with the environmental influences, the so-called irritants, and the manner and mechanism of their action. Thus, there has developed an experimental cell morphology which is already giving us a deeper insight and better definition of those morphological changes which lead to degenerations and to growth. We are able to follow and explain movement and ingestion of foreign particles by cells with much greater precision and we are learning to recognize the general laws which govern cell life and structure. It may be mentioned here that the direct observations of fresh tissues and cells by the ultra-microscope are modifying many of our ideas regarding the nature of parenchymatous degeneration, fatty metamorphosis and other things, and they open the door for renewed investigation of other cell problems.

V

It is, of course, impossible within the scope of this short review to enter into further details, or to even mention all the other possibilities which are still open to pathological morphology. Much might be said about the growing importance of morphological study into the problems of origin, paths of invasion and progress of infections, and their different manifestations as they are modified by structural organization. To mention only one or two examples: The fact that in tuberculous infections of the lung, the intestinal path is receiving more adequate attention, and that the idea of "inhalation tuberculosis" so generally believed to be the important method of this infection in the lung until only a very

short time ago, is losing more and more ground, is a progress in our ideas of tuberculous pathogenesis which we owe largely to morphological research. One other: the local tissue changes and their disintegration products which are consequent upon an infection, are gradually being recognized as of profound importance in regard to the production and specificity of disease. For it appears that not only are the infecting organism and its products responsible for these, but, perhaps largely, the type of the tissue involved and the changes produced in, and by, it.

Thus also, a great deal might be added regarding the important position which morphology still holds in the investigation of tumours. But it must suffice to have pointed out at least some of the new paths along which the prosecution of pathological morphology may continue with as much benefit to the science of medicine in the future as it held in the past.

It seems proper that a contribution of this kind should be included in a series of papers devoted to the memory of William Osler. For no one had a greater appreciation of the importance of morphological research and teaching in relation to medicine than he. He emphasized it, throughout his long career, by speech and writing, and what has been said above is, I believe, of his spirit and conviction.

WAR MUSEUMS

THE TEACHING VALUE OF MEDICAL WAR MUSEUMS*

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A discussion of this subject pre-supposes that the material is properly preserved, mounted, and catalogued. The chief problems are the selection of material, its relation to other museum specimens and its place in medical education. These are somewhat inter-related, but may be discussed *seriatim* for the sake of brevity.

The selection of material in this field of pathology must of necessity be made with the clinical bearing always in mind. Therefore, in so far as possible, an abbreviated clinical record

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should be attached to the specimen. Actual records of this sort are of much more value to the student than any imaginary records that may be substituted by the teacher. A factor of further importance is the grouping of certain types of cases, as in the writer's series of cases of acute endocarditis following war wounds (Archives of Internal Medicine, 1918, XXII, 296. Transactions Association American Physicians, 1918, XXXIII, 211.) This same principle of grouping may be applied to numerous other conditions, as, for example, gas gangrene and the effects of war gases. Groups of histological specimens may be added to the museum with great profit, as for example, the studies of Warthin on mustard gas. The great variability of pathological manifestations makes it extremely important that the grouping of material be adhered to in order to give a comprehensive impression to the student. This necessitates the collection of material in considerable quantities and from a large number of sources. Hence the small individual collections should be sacrificed in order to benefit the more important larger collections. At the best such individual collections should be confined to duplicates of material furnished for larger museums. Thus only may the full value of central museums be realized.

Just as a medical curriculum should be properly balanced, so should the material in a medical museum. Military medicine occupies a small part of the attention of students in the medical schools, it being supposed that those who take up military medical work as a permanent profession will receive further training in a my or navy medical schools. In every war, however, much is learned in a medical way that has definite value in civil practice, thus enhancing the value of war museum material. If it be true that war is now banished from the earth the war museum has only historic value plus whatever application of the collection may be made to civil life. If on the other hand it be true that nations must be prepared for war, so must the medical profession be ready to play its part. This part is fundamentally that of training skilled physicians and, secondarily, that of teaching the essentials of what medicine may be in war time. Correspondingly, the war museum of the army and navy medical schools should occupy a large part of the museum space, on the presumption that the student is properly trained in general medicine before receiving his degree; and the war museum in the general medical school should occupy a relatively small part of the museum space unless it be accepted that the function of such a school is to train men to enter immediately upon military work. Such function can hardly be required, except in distinctly military nations, or in nations

which are so small that the special training of medical officers can not be obtained

The position of the war medical museum in medical education presents a twofold problem, that of military medicine in medical education and that of the museum in medical teaching. The first of these has been discussed in the preceding paragraphs. The museum, as at present constituted, is one of the unsatisfactory features of medical education. The only material that is satisfactorily preserved in the museum is that from the skeleton. Such material is indeed seen at its best after complete preparation. Much of practical importance in the pathology of the skeleton, however, is the relationship to the soft parts and whilst some of this may be fairly well shown, it is nevertheless true that no method has yet been devised that will preserve the soft parts of the body so that color and consistency can be determined with accuracy. If the student is to gain a clear idea of the pathology of the living he must of necessity see fresh material. This, however, even in the largest hospitals, means a sacrifice of continuity of presentation, and the question arises as to whether or not continuity should be so sacrificed for the advantage of utilizing fresh material. The writer thinks this a small sacrifice in proportion to the difference in actual teaching value between fresh and preserved material. Under these circumstances the museum serves a very small part in the teaching of gross morbid anatomy. Fortunately for humanity fresh war material is only occasionally available to the practitioner and practically, never to the student in course. Therefore, if the student is to see the gross morbid anatomy of war he must suffer the disadvantage of seeing it in preserved form, a disadvantage far less now than in former times, but one which must be minimized by vastly improved museum methods. This should be the stimulus of the museum worker, that in improving methods he improves medical education by making it possible to present gross morbid anatomy in a progressive and continuous manner and that by the same process he improves the preparedness of the medical profession to combat the horrors of that greatest of horrors, war.

OVERCOMING THE DIFFICULTIES ENCOUNTERED
IN THE COLLECTION, STORAGE, AND SHIPPING
OF SPECIMENS IN FRANCE*

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Museum work in the A. E. F., although supported in every way possible by those in authority, was carried out under very difficult conditions. The lack of experienced pathologists and the irregular distribution of their work in most cases caused them to be so burdened with routine that special attention to the care and preservation of specimens was oftentimes impossible.

The choice of a proper fixing fluid was one of our first difficulties. In many cases neither potassium nor sodium salts for the first Kaiserling solution could be obtained and we were compelled to use dilute formalin. Dilute formalin always has the disadvantage that weak organic acids are usually present in the solution and increase in the presence of the tissues. These acids decolorize the specimen and render impossible any future color restoration. It was manifestly impossible to carry the specimens through to the final Kaiserling preservative. Consequently, it was decided to ship these specimens to the museum in Washington in the original solution in which they were preserved. Proper storage facilities were often difficult to obtain. In several instances we solved this problem by obtaining wine barrels, sawing them into two portions, coating them with paraffin, and fitting covers. In one hospital a large vat was made of wood, caulked with oakum and pitch, and then coated with paraffin.

Many of the specimens that came to us from evacuation hospitals were improperly labelled or not labelled at all. One of the simplest methods of labelling, in the absence of ideal materials, such as linen, India ink, fibre tags, etc., was found to consist of pieces of heavy paper or labelling cards, which, after properly labelling, were dipped in paraffin and attached to the specimens by thread. After a sufficient number of specimens had been collected they were packed in barrels or wine casks, first being securely wrapped. This wrapping process called for cotton, but cotton was scarce and needed for other purposes. Consequently we found that we could substitute moss which had been sent to

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the Red Cross for use in dressing large wounds. Some of this moss by experiment was shown to be pigment free but later on portions of it were found to contain a brownish pigment which perhaps stained the specimens. The specimens were placed in cotton bags, the moss crowded around the specimens in these bags, and the bags closed. This wrapping was for the purpose of keeping the specimens moist without requiring too much free fluid in the shipping case. The question of accompanying records gave some trouble. If the records were sent by mail they were liable to be lost, or to be separated hopelessly from the specimens to which they referred. Consequently, we made duplicate sets of records, and sealed one set in the barrel of specimens to which it belonged, first binding these records into a closely wrapped bundle and then covering them entirely with paraffin.

Large masses of tissue, such as limbs affected with gas gangrene, required to be incised or punctured in order to allow proper fixation. Colour preservation in these large masses of tissue was deemed almost impossible. Oftentimes it was necessary to keep these specimens in their original solution for many months before their final transfer to Washington, and I am rather doubtful as to whether any colour restoration was possible in these specimens, although the museum authorities of the British Army under the direction of Sir Arthur Keith reported that specimens could remain in the first Kaiserling solution as long as six months and still be restored.

The Kaiserling method was chosen as the most ideal method of colour preservation, as the majority of workers in this field through several years experience in the British Army agreed that other methods were not as satisfactory as the Kaiserling.

EXPERIENCES IN THE COLLECTION OF MUSEUM
MATERIAL FROM ARMY CAMP HOSPITALS*

JAMES EWING

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In a history of the Army Medical Museum recently compiled by Dr. Lamb, the author states that during the Civil War, Woodward, failing to get material from the army camps, gathered up a company of darkies, hired some mule teams, drove to the battlefields near-by, exhumed buried limbs and bodies, and brought the pathological specimens to Washington himself. One cannot help expressing admiration for a man who collected pathological material under such difficulties, and then submitted it to an analysis and study, which in scientific scope and detail has hardly been surpassed in American literature.

During the year 1918, most of the good material, and all the really first class specimens received at the Museum, with few exceptions, were brought there by men sent from the Museum to get them.

The factors which brought about the same results fifty years ago and to-day were probably very much the same. This collection of pathological museum material was one of the least urgent matters claiming attention in an army whose task was to win the war and win it quickly. In the camp hospitals a succession of epidemic diseases overtaxed the capacity of the available laboratory staffs, and at such times there was neither time nor force to collect suitable pathological specimens and preserve them according to modern methods. Also the number of men in the American medical profession trained in the methods of the pathological laboratory and especially in the methods of museum preparation proved to be extremely small, and few of these were available in the army. Finally, the lack of preparedness in so many other medical essentials, the failure to provide beforehand the means of collecting, preserving and shipping pathological material, all contributed to thwart the efforts of the few pathologists who made a consistent effort to meet the requirements of the situation. It must be admitted, I think, that many of these difficulties were unavoidable, but also, that their presence made the

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task of collecting suitable pathological material for the museum at Washington almost insuperable. Nevertheless, plans for the collection of pathological anatomical material were conceived at an early period and in considerable scope. In 1917, orders had been given that all pathological material received at camp hospitals should be sent to Washington. Under the existing conditions it was practically impossible to carry out such orders, and they fell down at nearly every point. At one time permission for the performance of autopsies was suspended, but this situation was shortly relieved by the Surgeon General's Office. Accordingly, the only material received at Washington from 1917 cases was sent by one or two pathologists whose attention to the needs of the museum had been specifically and urgently directed.

When, in the early summer of 1918, material failed to arrive at Washington, the writer was detailed to visit several of the eastern cantonments in the interest of the museum. On these visits it became apparent that the laboratories had been built, equipped and manned, chiefly for clinical microscopy, and not for pathology. There was always an impressive array of test tubes, Wassermann trays, blood counters, urinometers, etc., and a rather superabundant personnel trained in their use, but I found the pathologist at only one of the seven hospitals visited, and he was busily engaged as admitting officer of the hospital. Autopsies had been made, however, at all of them and at two there was an effort to collect a local camp museum of interesting cases, which the local doctors were extremely loth to part with. At times the frequent transfers of the acting pathologist, doubtless necessitated by the demands of the service, told against the effective preservation and control of material. All complained of the difficulty in securing proper containers for shipments. There was usually sufficient help to obtain abstracts of histories and autopsy protocols. The autopsy rooms were usually adequate. Most obvious was the lack of knowledge of the methods of museum preparation. Only the old-fashioned pathological anatomist made any headway toward securing good anatomical material.

On returning to Washington it was decided to issue a pamphlet containing explicit directions for collecting, preserving and shipping gross anatomical material, and to provide shipping containers for the camp hospitals. Yet this circular did not reach many of the camps until late in the autumn. It was preceded by letters of appeal addressed to many camp pathologists personally known to the museum staff. At the same time certain non-medical members of the museum staff were trained in the methods of museum preparation, and one of these, detailed to Camp Wheeler, secured

through the co-operation of the pathologist, most of the really good specimens of influenza lungs that are now in the museum. This man was permitted to remove the organs from the body and preserve them before random incisions were made. He worked over them day and night until fixation was perfect, packed them himself, rode on the wagon that carried them to the station and saw them off on the train.

Yet in spite of many difficulties from the very first, the clever hand of the well-trained pathologist could be recognized by the receipt from several sources of well-selected and well-prepared specimens.

It is a pleasure to acknowledge the indebtedness of the museum to Dr. W. G. MacCallum, who sent a large number of pneumonic lungs which formed the sole representatives of the epidemic of 1917-18. One should not forget also that during the critical days of the influenza epidemic of 1918, many competent pathologists were quite unable to do anything for the museum because of the great amount of work thrust upon a wholly inadequate staff. Thus in one camp, the pathologist performed ten to fifteen autopsies daily for a time and sent to the museum seventy-five lungs badly cut to pieces and in a well advanced state of decomposition.

The camp museum also worked against the interests of the central collection. Many a rare and valuable specimen told its tale to a changing personnel of a medical staff, gradually to lose interest and finally to fall into oblivion when the pathologist himself moved on. Personally, I sympathize with the camp pathologist, and I do not see how any effective collection of pathological material could have been made under the conditions provided, and there is no doubt that much heroic work is represented in the material, good and bad, that was sent to the museum.

When the material reached Washington there were scant facilities at the museum to receive it. As a lone sentinel guarding the interests of pathological anatomy, stood Dr. Lamb crowded into two small rooms, but faithfully performing his function day by day as he had been doing year by year. With rare generosity he placed at the disposal of the staff of new men, his valuable museum collection of microscopes and laboratory utensils. More rooms were secured, but the credit for transforming them into a pathological laboratory belongs to Major C. Judson Herrick, who worked for months under great handicaps on the task. He also gathered a staff of enlisted men of unusual capacity and trained them for the work of a pathological laboratory. By the date of the armistice the museum laboratory was in fair working order,

a constant flow of material of all grades was arriving, and the work was being separated into three divisions: general pathology, neuropathology, and surgical pathology, each under the direction of a specialist.

Elaborate preparations for making permanent illustrations of pathological lesions were at one time in full progress. There were plaster and wax artists, photographers, and watercolour experts at hand, and for a brief period several of them were at work, but the armistice soon terminated their activity. Unfortunately, the museum did not possess a good photographic lens or apparatus, which hampered the work of its skilful photographer. He and his considerable staff were mainly occupied or submerged in bill poster work for the S. G. O.

A modern photographic outfit and a staff acquainted with pathological problems were greatly needed. I wish especially to call attention to the remarkable effects in colour and detail secured by an artist who colours photographs of pneumonic lungs and other lesions, and whose results were far superior to any that I have seen from any other methods. He should have been made a permanent attache of the museum.

The effort to obtain good histological material and to prepare good microscopic specimens was not very successful. Here let me observe that the going methods of the pathological laboratory are somewhat different from those of the biological and strictly research laboratory, and that in order to obtain results with a large amount of pathological material it is necessary to adopt the methods of a pathological laboratory and to have men who have had experience in such a laboratory. Also, since most of the material came to us fixed long in Kaiserling it was not easy or even possible to obtain good histological sections. I now believe that it was ill-advised to attempt such a task at the museum, and that the histological work should be assigned and completed at the hospital where the case occurs.

Colour preservation in the material received from a distance was on the whole unsatisfactory or a complete failure, no matter what agent was employed. The exception was in the specimens prepared by the representatives of the museum at Camp Wheeler. From several hospitals in the neighbourhood of Washington, however, the usual fine colour preservation from Kaiserling, Klotz, or 10% formalin was generally obtained. It seemed to make little difference which of these fluids was used, provided the organs were carefully handled, but the museum staff came to prefer Klotz' fluid for their own work.

The mounting of specimens made little progress until the

arrival of Lieut. Ellis whose artistic work soon filled the available supply of jars, after which time many fine specimens had to be packed away in earthen crocks.

In November, 1918, shipments began to arrive from the A. E. F. The main diseases represented were pneumonia, gas poisoning, and infected wounds requiring amputation. The specimens were well preserved in formalin. By careful and intelligent dissection Capt. Haas added to the museum many instructive specimens of fractures and infected wounds. The pneumonias were similar to those observed in America.

To a general pathologist the opportunity to observe such a large amount of material, from many different sources, was extremely interesting and instructive. Much that was unsuitable for a museum was still valuable for study, and amply justified the labour and expense of its shipment. The variety of diseases represented was surprising and the opportunity of illustrating the developmental stages of common and even of rare diseases, with their complications, was far greater than the writer has ever before enjoyed. Hence the value of an extensive museum collection was very completely demonstrated.

Thus with specimens of pneumonia numbering over a thousand it was possible to compare the lesions, in different years and seasons, at home and abroad, from different camps, and with varying bacteriological data. It seems probable that highly important deductions not otherwise obtainable might be drawn from such a study. Empyema was quite fully illustrated by many specimens from several sources, and a rather characteristic group of pulmonary lesions was found to belong to this group, which may throw light on the pathogenesis of empyema. Unsuspected tuberculosis of the pleura was sometimes found in cases of empyema progressing unfavourably. Pulmonary tuberculosis appeared with considerable frequency.

All the common and nearly all the rare varieties of meningitis were represented by one or several cases, including meningococcus, pneumococcus, streptococcus, anthrax, tuberculous, syphilitic, and other types. Endocarditis, old and recent, in many phases was to be seen. Typhoid fever was not lacking, in both vaccinated and unprotected subjects, but the lesions seemed to lack the severity and extent of those observed in the Spanish War. Leukemia, lymphosarcoma and Hodgkins' disease were occasionally encountered.

A surprisingly large number of tumours was received, fairly representing the types of malignant neoplasms occurring in young adults. These lesions seemed to commend themselves to the camp

pathologists as desirable museum material. The hazards of salvarsan poisoning were emphasized by the organs of several fatal cases, in some of which no signs of syphilis could be found. Status lymphaticus appeared in a high proportion of the fatal cases of infectious diseases, acute endocarditis, Addison's disease, salvarsan poisoning, and in other interesting connections. Strong confirmation of the military importance of this condition could be secured from the extensive material gathered at the museum. Particularly valuable for this purpose was a collection of pneumonic lungs with the heart attached, secured from Camp Grant. In the great majority of cases abstracts of the clinical history, autopsy protocols and rather full bacteriological data accompanied the specimens.

Several general considerations seem to the writer worth recording as he reviews at some distance the brief period when he was privileged to work in the Army Medical Museum.

(1) The value of a comprehensive pathological museum for teaching students, clinicians and pathologists, and for research in the etiology and pathogenesis of disease is probably underestimated even by most confirmed pathological anatomists. Although confessing long devotion to pathological anatomy, the writer was forced to recognize at Washington possibilities in this field which he had never before conceived. To accomplish these possibilities the collection must be very large, well-chosen, thoroughly studied in the light of clinical, microscopic, and bacteriological data, and artistically prepared and displayed.

Unless this estimate is badly overdrawn, then the plan formulated by Col. W. O. Owen, the Chief Officer of the Museum in 1918, that the U. S. Army should establish at Washington a pathological museum, comparable in its scope with the library of the Surgeon General's office, is as wise as it is far-reaching and formidable, and deserves the endorsement of the American medical profession. Probably no other institution than the army with Government support can develop and maintain the world-wide organization necessary to secure the material. It would be a pity if the Army narrowed its vision to the particular needs of military medicine as its medical officers can now see them. Current views, however competent, may be completely altered with the progress of medicine. Military medicine means the whole of medicine.

Then, also, medical schools must regard the possession of a large museum as an essential part of their teaching equipment and must be prepared to spend the time and money required to collect and maintain such a museum. In recent years strong efforts have been made to divorce the teaching of pathology from

the dead house and the laboratory and bring it into live contact with the wards. This movement has many commendable features, but unless it is preceded by a broad knowledge of pathological anatomy it is building without a foundation. A study of fifty museum specimens of gastric cancer representing all types, locations and complications of this disease is far more valuable for a practitioner than acquaintance with a great variety of clinical laboratory tests for this disease. The latter type of information can be safely interpreted only in the light of the former. Both are essential for the safe diagnostician.

(2) The surprisingly small number of pathological anatomists in the country and the general lack of knowledge among so-called laboratory men of autopsy technique, interpretation of findings, histopathology, and especially of museum preparation, as revealed by the war, are mainly the fault of the medical schools and the teachers of pathology. It is also chargeable to the clinicians governing hospitals who usually provide for clinical microscopy, blood chemistry and serology, but last, least and often not at all, for pathology. It is evidently high time for teachers of pathology, especially for members of this Association, to insist on a knowledge of autopsy technique, wider acquaintance with pathological anatomy, familiarity with histological methods, and definite instruction in museum preparation, as requisites to graduation, and to demand the necessary time in the curriculum to accomplish these results. In outlining plans for instruction of military medical officers, the Surgeon General's Office decided to require that five per cent. of the medical students in the S. A. T. C. should be trained pathologists. The question may be asked of medical schools whether less than this proportion is required in well balanced civil practice. Probably not one per cent. of the present medical classes is thus equipped.

A further problem for this Association is the standardization of the technique of autopsies and of methods of museum preparation. In compiling a circular of information regarding museum preparation for the S. G. O., the writer consulted many pathologists, members of this Association, and encountered wide and even irreconcilable differences of opinion. There is certainly some common ground on which all can meet, while giving reasonable latitude for individual initiative. General agreement among pathologists would greatly assist instructors in this field.

(3) The failure of pathological anatomy to receive proper recognition in the army medical service seems to call for the formulation of some plan which will prevent a recurrence of some unfortunate experiences of the war. Doubtless this matter will

receive full consideration by the military authorities. The writer would presume to suggest only that in the regular army medical force, the state militia, or in the medical reserve corps, or all these organizations, provision and personnel should be provided to meet the demands of this branch of the service, that it should be recognized as a definite specialty requiring particular qualifications and experience, and that all men available for such service should be card-indexed and assigned to specific duty before the call for mobilization or military service shall come upon us.

THE PREPARATION OF THE CANADIAN ARMY
MEDICAL MUSEUM, AND ITS DESCRIPTIVE
CATALOGUE IN COLLABORATION WITH
EXPERTS*

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Ottawa, Canada*

The participation of any nation in the awful carnage of war, brings with it, by the inevitable law of compensation, certain benefits. The national consciousness is deepened to a more lively sense of patriotism; and, by the actual experience of the exigencies of active military conflict and its effects, a positive knowledge is gained that may be used as a future basis of improved technical methods. The necessity of the conservation of the knowledge so obtained by the publication of a systematic historical record is recognized by all civilized peoples today. Such considerations apply especially to the humane work of the Army Medical Services, whose progress conduces so enormously to the amelioration of suffering in modern warfare; and in the preparation of a Medical History of War, an Army Medical Collection illustrating the pathology, treatment and sequelæ of war lesions, occupies an essential place. "Such specimens," in Sir Arthur Keith's words,**

*Presented at the 13th and 15th Meetings of this Association, April 1st. 1920, and May 1st, 1922.

**Address delivered at the opening of the British War Exhibits, *B.M.J.*, October 20th, 1917.

“are original documents; they constitute an original and reliable source of knowledge for all time;” and they supply the most valuable and reliable basis possible for present and future treatment of diseases and injuries of war, and are, therefore, to be recognized as the basis of its Medical History.

THE BRITISH MEDICAL HISTORY COMMITTEE AND THE IMPERIAL COLLECTIONS

A word on the formation of the British Medical History Committee of the Great War of 1914-18, and its corollary, a British Army Medical Collection (of which the Canadian Army Museum naturally forms a part), is in place here. It will be of interest to members of this Association to learn, from General Sir William MacPherson's Introduction to the first volume of the British Medical History of the War* and from other less official but equally authentic sources, that the first impetus to the organization of that Committee early in the autumn of 1914 for effective action on the extended and scientific scale of its subsequent operations, was given in a suggestion made by Prof. J. Geo. Adami, now Vice-Chancellor of the University of Liverpool, but at that time Professor of Pathology at McGill University. In a letter written to the late Sir William Osler, from Montreal on September 14th, 1914, and subsequently published, at the latter's request in the *British Medical Journal* for October 20th, 1914, Dr. Adami pointed out the great results that had accrued from legislative action taken early in the American Civil War in the establishment of the Army Medical Museum and Library at Washington, and urged that immediate action be taken by the British War Office to a like end. The matter was subsequently brought by Sir William Osler himself before the proper authorities, and at the same time (October 31st, 1914) a revised plan of action was put forward by the Medical Research Committee (see *British Medical Journal* for December 5th, 1914), which proposed, with the approval of the War Office, that its statistical staff undertake the whole work of dealing with the medical statistics of the war and to supply financial support for such undertaking from its funds. In all these preliminary arrangements for the organization of the British Army Medical Museum and Medical History of the War during the winter of 1914-15, Sir William Osler, himself a member of both Committees, was undoubtedly the moving

*History of the Great War, based on Official Documents. Medical Services: General History, Vol. I, by Major-General Sir W. G. MacPherson, K.C.M.G., C.B., L.L.D., London, 1921, page viii.

spirit and active agent, at a time when the official authorities, Sir W. M. Fletcher and Sir Alfred Keogh were both necessarily absorbed in matters of more directly pressing military interest.*

The Canadian Army Medical Museum itself took form as the direct result of the action taken by the British Medical History Committee immediately after its inception in November, 1914, for the collection, on a strictly Imperial basis, of pathological material for War Museum purposes by the Medical Units of all countries



CANADIAN ARMY MEDICAL MUSEUM EXHIBIT AT MONTREAL MEETING OF AMERICAN COLLEGE OF SURGEONS, OCTOBER 12TH-15TH, 1920.

Fig. I—View from foot of hall shows:

A. War injuries of bone prepared in the field by Major L. J. Rhea, C.A.M.C., and mounted under specially constructed brass-bound glass shades by E. L. Judah. (See articles by these authors below).

B. War lesions of soft tissues, mounted in square jars, with type exhibit, Silvester's method, in centre.

D. Reconstructive surgery: (*b*) Wax models and plaster casts of face at successive stages of repair.

E. Type deformities.

H. Captured equipment.

(Photographic enlargement of a heart with the coronary circulation, injected by method of Louis Gross. At head of hall).

*On this subject see also the articles by Sir Arthur Keith and Professor Adami in the Special Sir Wm. Osler Memorial Bulletin (No. IX) of this Association.

serving under the British flag. Under this regulation all specimens obtained in the field were, technically speaking, the property of the British War Office, and to be forwarded in the first place to the official receiving depot in England as such, but they were to be ear-marked at the hospital or clearing station collecting them, with the name of their ultimate destination to that country of the British Empire, from which the Unit collecting them had been drawn.

The great event for the Imperial Army Medical Collections came in May, 1915, when the Council of the Royal College of Surgeons of England was called to the assistance of the Medical History Committee, and its Museum was made the official depot for the reception and conservation of all pathological material. A revised circular memorandum containing explicit directions for the collection, preliminary preparation and shipment of material was immediately issued to all parts of the War Zone, and the Staff of the Royal College of Surgeons, headed by Sir Arthur Keith and Sir Ernest Shattuck, and assisted by an army of volunteers, threw their energies into the work of dissection and preparation and indexing of records. Eighteen months later results were presented to the British public in a great Imperial War Exhibit, which was opened by addresses and was largely attended by the British public.* One of the most important features of this exhibit, both from the technical and scientific standpoints was the collection of Diseases and Injuries of Bone prepared by Major L. J. Rhea, C.A.M.C. as Pathologist to No. 3 Canadian General Hospital (McGill). These specimens were macerated and mounted in the field, and in spite of the difficult conditions imposed, were brought there to a high degree of technical perfection, the delicate processes of repair in bone being placed in situation with the aid of x-rays made during life. In addition, each specimen was made the subject of a complete clinico-pathological study carried out with the aid of the surgeon in charge of the patient during life. The whole constituted a collection unique in the history of the war and a brilliant example of the triumph of personal skill and intelligent collaboration over superficial difficulties; the entire collection was sent forward intact by the Imperial Government to Canada, with the remainder of the material of the Canadian Army Medical Museum, and constitutes today its most artistic and valuable section (see Fig. I. and the articles on The Technique of Preparation of the Specimens, by L. J. Rhea, and construction of Glass Shades for the same, by E. L. Judah, in this issue).

**Locus cit.*

RECEPTION AND PREPARATION IN CANADA

Immediately at the close of the Imperial War Exhibit, arrangements were made for the despatch of specimens to the various countries to which the units attaching them had belonged. In March, 1918, the first consignment of specimens destined for the Canadian Army Medical Museum reached Canada. Following the policy carried out in England of making the Royal College of Surgeons the central receiving depot, it was decided to make the Pathological Museum of McGill University, the staff of which had for many years concentrated on the work of museum preparation, the official receiving depot for the collection. The permission and co-operation of the University authorities having been obtained, this first consignment was duly received and was immediately put in order by the Curator and Staff of the McGill Museum, and exhibited by permission of the Government, at a meeting of the Canadian Medical Association held at Hamilton, Ontario, in May 27th–June 1st, 1918. The next step was taken in January, 1919, when it was finally settled that the preparation, mounting and cataloguing of the entire pathological material should be carried out at McGill University, under the charge of Dr. Maude E. Abbott, Curator, and Mr. E. L. Judah, Preparator, with the assistance of Major F. B. Gurd, C.A.M.C., in the cataloguing of moist specimens, and Sergeant J. Giroux, as technician, the Curator being permitted to indent on stores and the administration being controlled by the Officer-in-Charge of the Army Medical Museum and Library at Ottawa, who was at that time Major G. A. Campbell, C.A.M.C., (replaced later by Col. H. A. Chisholm, C.M.G., D.S.O., C.A.M.C., and then Col. A. E. Snell, C.M.G., D.S.O., R.C.A.M.C., and Major Gorssline, D.S.O., R.C.A.M.C.), acting under the Director-General of Medical Services, then Major-General J. T. Fotheringham, C.M.G., C.A.M.C. Under this arrangement the work went steadily forward to completion.

In October, 1920, the entire material mounted to date, together with all other material in the hands of the Canadian Government for Army Medical Museum purposes, was placed on exhibition on the occasion of the meeting of the American Congress of Surgeons in Montreal, and made an imposing and interesting display. (See Fig. I).

In addition to the pathological material sent forward from the Royal College of Surgeons, the C.A.M. Museum collection had now come to include exhibits illustrating plastic and facial surgery; models on orthopædic surgery; enemy and allied equip-

ment; x-ray lantern slides of war lesions; traumatic lesions of the fundus of the eye; and water color sketches of Army Medical arrangements made under military instructions in the field.

DESCRIPTIVE CATALOGUE IN COLLABORATION WITH EXPERTS

In the summer of 1921 a further expansion in the work of the C.A.M. Museum was decided upon by the Canadian Government, under which all the sections of the Canadian Army Medical Museum, in which material was or could be made available, should be expanded into teaching series, and a scientific descriptive catalogue prepared of each in collaboration with subject-editors, experts in their respective fields, the whole under the direction and the editorial management of the Director-General of Medical Services and Major-General J.T. Fotheringham, C.M.G., C.A.M.C., with the assistance of the Acting Curator of the C.A.M. Museum and a competent Editorial Board, along lines followed in the Sir William Osler Catalogue of the Pathological Museum of McGill University, in which a detailed catalogue of the objects in each series with clinical history, microscopic findings and bibliography attached, is preceded by a short introduction bearing upon it, written by its expert subject-editor. The completed catalogue is to be published by the Government Press in a series of volumes covering the following subjects: *War Lesions of Soft Tissues*; *Diseases and Injuries of Bone*; *Special Surgery* (Orthopædic and Facial); *General Surgery* (including Chest Surgery, Cranial Lesions, Transfusion and Wound Irrigation Apparatus); *War Lesions of the Eye and Ear*; *War Medicine* (includes Renal Medicine, Chest Medicine, and Cardio-vascular Disease); *Enemy and Allied Equipment*; *X-Ray of War Injuries*; and *Field Sanitation*. The Museum Collections on which these volumes are based consist, in addition to the pathological specimens obtained in the field, which naturally constitute the most important part of the collection, of charts and diagrams illustrating results of treatment, statistical or metabolic studies on cases made during life, models of emergency camp fixtures, devised in the field, apparatus and pictures of diagrams illustrating its application, as well as plaster casts, wax models, photographs and water color pictures. The whole constitutes a new departure in the objective presentation of the field of war medicine which will be of great value for Army Medical teaching, and which is undoubtedly qualified to carry out the intention of the Government to produce a permanent and worthy record of the noble activities of the Canadian Army Medical Corps in the Great War.

Technical Methods

METHOD USED IN THE ARMY ZONE FOR THE PREPARATION OF BONE LESIONS RESULTING FROM THE INJURIES OF WAR

*(Specimens in Canadian Army Medical Museum)**

LAWRENCE J. RHEA, MAJOR, C.A.M.C.

Pathologist No. 3 Canadian General Hospital (McGill) Boulogne, B.E.F., France

Particular emphasis should be given to the importance of clinical history, detailed description of gross fresh specimens and clinico-pathological correlation.

I. DISSECTION AND DESCRIPTION OF GROSS SPECIMENS

(a) The dissection of the gross specimen should be done with the medical officer in charge of the case. If this is not done the very important clinico-pathological relation may not be sufficiently appreciated and correctly interpreted.

(b) Careful notes and drawings should be made at the dissection, showing the position of fragments of bone and their relation to important anatomical structures. If this is not done the fragments of bone cannot be put in the same relative position in the mounted specimen as they were in the gross specimen, and unless this relative position is obtained the difficulties of the surgeon may not be fully appreciated. We have found X-ray plates, taken during life or after the gross specimen was obtained, to be very helpful in reconstruction.

II. THE PREPARATION OF DRIED SPECIMENS

(a) Remove most of the flesh, being careful not to detach callus. This, when young, comes off very easily. If B.I.P. has been used this should all be removed.

[*The specimens prepared and mounted in the Field after the method described below form one of the most important and artistic features of the Canadian Army Medical Museum collection. They are shown under the glass shades devised to cover them in Fig. I, of the preceding article.—Ed.]

(b) Put the specimen in the container that will not rust, as rust stains on bone are removed only with great difficulty. All the smaller fragments from each specimen should be placed in separate containers, as small glass jars, and put in the larger containers. By this means the danger of mixing the small fragments is overcome. Cover with tap water. Do not wrap specimens in gauze.

(c) Incubate at about 33° C. We have obtained satisfactory results from an incubator made from a garbage tin, a gasoline drum, sawdust, an electric light and an enamel pail. Place a small brick in the bottom of the garbage tin and set a gasoline drum on it. Fill the space between the two with sawdust. In the bottom of the gasoline drum place a brick, set the enamel pail upon it and place an electric light on the bottom of the drum. Use a carbon light; a tungsten light will not give sufficient heat. Set the enamel pail inside the drum and cover the apparatus with old sacking. This apparatus will not hold a constant temperature but in our experience it has always given good results.

(d) Correct the reaction of the water every morning with KOH to distinct alkali.

(e) Change the water when needed—every two or three days.

(f) Skim off the fat and debris each morning.

(g) When the flesh has been removed by bacterial digestion, boil the specimen carefully in alkali, soap and water. Specimens which show callus, especially young callus, cannot be boiled long. Five to ten minutes is sufficient. After boiling, scrub with soap and water using a soft brush. Where there is younger callus, a soft tooth-brush should be used.

(h) Wash in several changes of water to remove soap, and dry the specimen in the sun or near the stove. When drying near a stove do not place the specimen too close to it as fissure fractures will open.

(i) After the specimens are thoroughly dry put them in gasoline, two or three changes, twenty-four hours in each. If benzine is available we would advise its being used. When specimens are placed in gasoline do not let them rest upon the bottom of the container as a colloid-like material is precipitated. From the last gasoline immerse the specimen in boiling water for five to ten minutes.

(j) Dry specimens in the sun or before a stove.

(k) Bleach in sun or in hydrogen peroxide. The latter gives the quickest results and can be used over and over if kept tightly closed.

(l) Dry specimens as above.

III. MOUNTING

In order that the various fragments may be placed in the same anatomical position as they were in the gross specimen it is necessary to drill holes in the fragments and support them by means of wire. The following is the necessary equipment:—Drills, assorted sizes; brass wire, assorted sizes (do not use copper, steel or iron wire); pinchers with rounded points; heavy scissors for cutting sizes; small hand centrifuge.

Satisfactory drills may be made from ladies' hat-pins and straight surgical needles. Cut off the points and by means of a stone grind two cutting edges.

Brass Wire: We had great difficulty in obtaining brass wire. Some of it was taken from the covering of piano-wire and the bass strings of bass violins. Copper, steel and iron will in time discolour the specimen.

Pinchers and heavy scissors may be obtained from any hardware store.

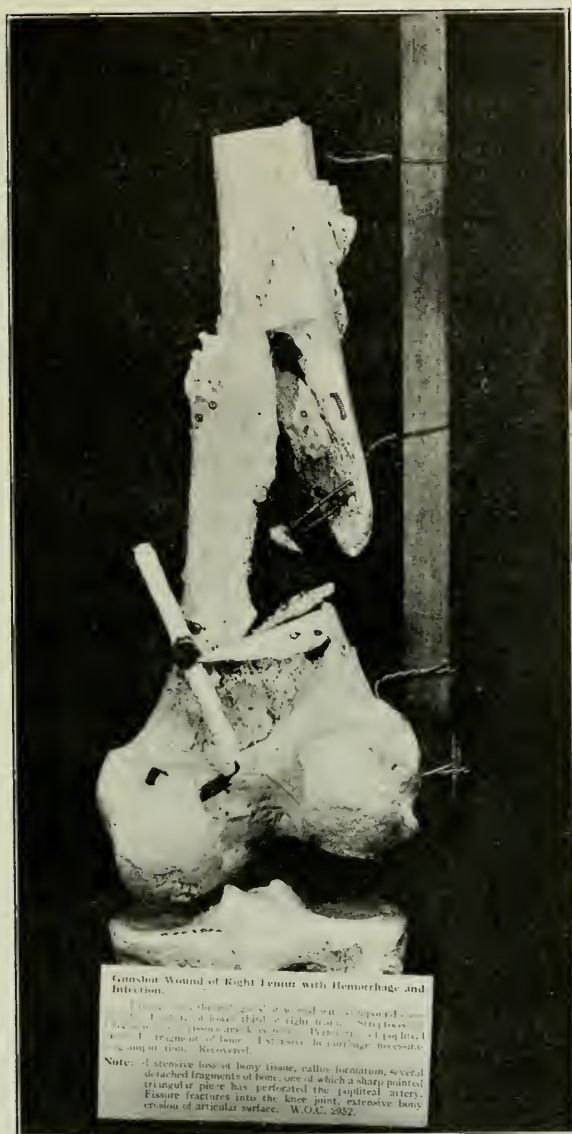
Wire Springs: We made all our wire springs by winding brass wire of different sizes about any straight round metal rod or wire and forcing the numerous coils close together. It is often found advantageous to heat the wire and put it, while hot, into cold water.

Any hand centrifuge may be used. Remove the plate that holds the centrifuge tubes. Pass over the upright pinion that holds the arms, and pull through weight in one end of which a drill has been firmly fixed with wooden or metal plugs. This apparatus gives good results.

Where detached fragments are to be placed directly one against the other they can be held in place by means of wire passed through and through. Displaced fragments may be held in place by interposing between the two pieces of bone a wire spring, through the centre of which a piece of straight wire has been passed. It is often necessary to use two or three of these springs on one fragment. One or more coils on the ends of the wire hold fragments in place permanently.

Most foreign bodies will rust unless they are coated with something. Shellac or varnish may be used.

We have found the following method satisfactory for permanently preserving blood vessels. Pass a glass rod through the lumen. Dehydrate in alcohol and paint with varnish or shellac. Blood vessels prepared in this way may be mounted with the specimen from which they were obtained and held in their proper position with brass wire.



Specimen of Gunshot Injury of Femur macerated and mounted in the field by technique described.

Note the replacement of fragments in situ (done with help of X-Ray plates made during life), and erosion of popliteal artery by spicule of bone, which led to fatal haemorrhage.—MAJOR L. J. RHEA.

We have found it more difficult to remove the flesh from bones by bacterial digestion in civil hospitals than in France. This is probably due to the almost constant presence of proteolytic organisms in the wounds inflicted in the War.

ON THE CONSTRUCTION OF GLASS SHADES OR
BOXES FOR THE DELICATE DRY SPECIMENS
FOR THE CANADIAN ARMY MEDICAL
MUSEUM*

E. L. JUDAH

Montreal

It has always been a recognized fact that macerated specimens of bone should be kept permanently in dust-proof cases. When such specimens are to be used extensively for teaching it is advisable that the cases be in the form of dust-proof glass shades, as small, delicate bits of bone are so easily knocked off and the fine lace-like particles of new growth can be ruined by careless handling in a class-room.

The difficulty, however, of getting such shades in the different sizes required, and the expense entailed, has always been beyond the means of the average museum. The home-made shade with passe-partout edges, while good in its way, always falls to pieces sooner or later and has to be remade.

To overcome these difficulties, I designed the following shades for the Canadian Army Medical Museum, which have turned out most satisfactorily.

All four sides and the top are set in brass angles and are securely soldered together, which prevents them from falling apart. Cement is applied to the inside corners and a round cotton lamp wick is placed in the bottom of the grooved slot of the base or pedestal, thus making them absolutely dust-proof.

The thickness of the brass for the angles depends on the size of the shade. For general purposes I use No. 24 Gauge and bend the angles about 3-8ths of an inch on each side of the box. A good technician can make from five to seven boxes per nine-hour day; and by using old X-Ray plates the cost can be kept well within the means of any museum. Any good tinsmith who has the

*Remarks submitted at the Thirteenth Annual Meeting of the American and Canadian Section of the International Association of Medical Museums, New York, April 1st, 1920.

necessary machinery for bending sheet-iron can make the angles at comparatively small cost. Care must be taken not to use any more solder than is absolutely necessary, filing off any superfluous amount.

The construction of these shades is best explained by the following figures:

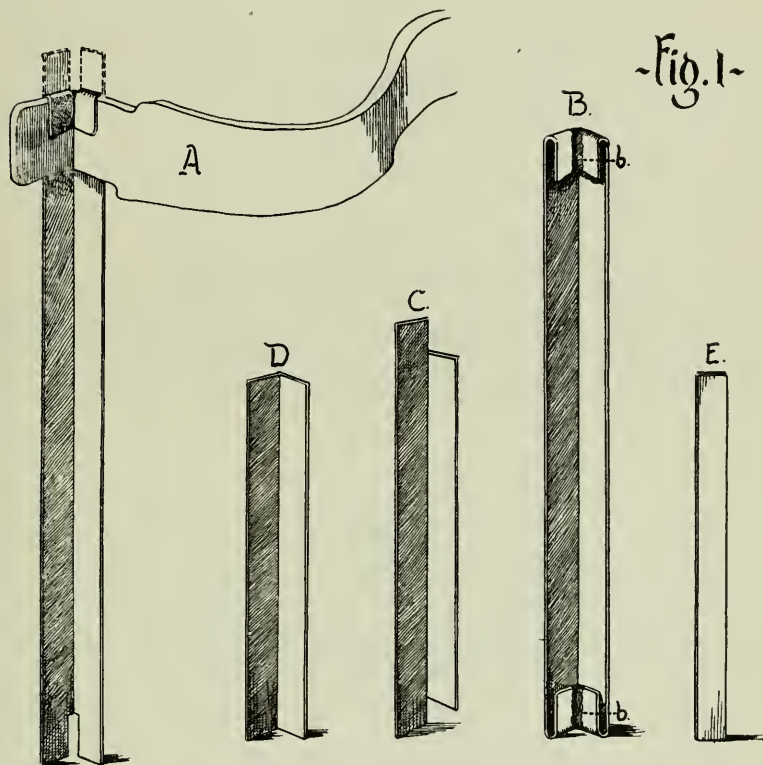


FIG. I.

Showing brass angles of frame before assembling of box,—

(A) The instrument on which the ends of the uprights are to be bent to hold the glass sides;

(B) One of the four uprights into which the glass sides fit; bb shows its upper and lower ends securely soldered;

(C) One of two top pieces which have a longer upper end lapping over the corner to conceal the end of the cover (H) in Fig. III. It also overlaps the upright angle (B);

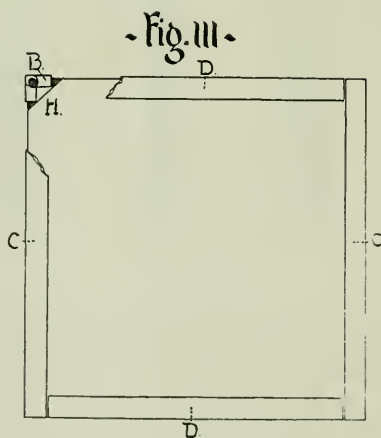
(D) One of the other two top pieces which have the ends cut square to fit against the upright angle (B);

(E) One of four plain, flat bottom pieces used only in large boxes to strengthen them and prevent the bottom from spreading.



Cross section of the lower end of the box showing two glass sides (FF) shorter than the other two (GG) by double the thickness of the glass.

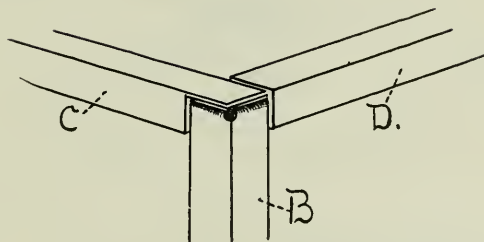
(B) Cross-section of the upright shown in Fig. I. (B).



Top of the box with brass strips removed at one corner of the cover to show how all four corners of the glass (H) are cut to allow the top to fit down even with the four walls and to be concealed by the top pieces of the brass frame.

(B) Upper end of soldered brass angle; (C) top pieces (D) top piece; shown also in Fig. I (B), (C) and (D).

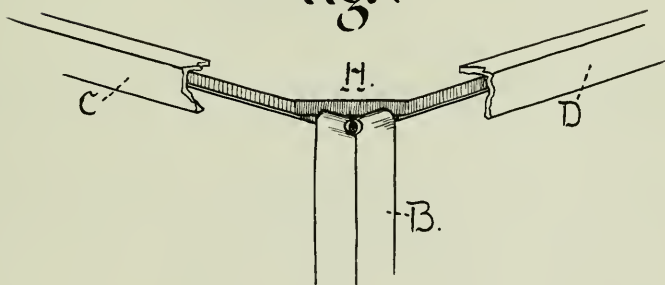
-fig. IV-



Shows one of the four corners where the different angles join, ready to be soldered:

(B) Upright frame; (C) overlapping top piece; (D) short top piece; shown also in Fig. I. (B), (C) and (D).

-fig. V-

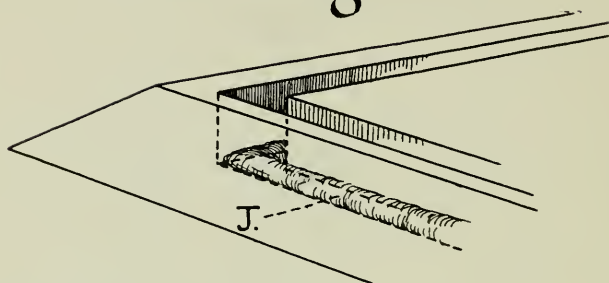


Shows same corner as Fig. IV., but with two upper brass pieces (C) and (D) removed to expose soldered upper end of brass upright:

(B) Brass upright as shown in Figs. I. and IV.

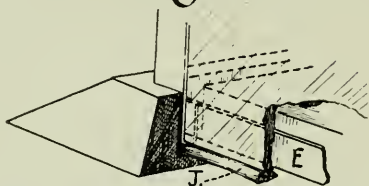
(H) One of the four cut corners of the glass top; shown also in Fig. III.

-Fig. VI-



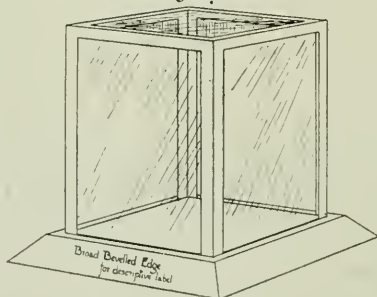
Shows slot in base or pedestal to hold box or shade.
(J) Round cotton lamp wick.

-Fig. VII-



Shows corner of box in slot with the inside brace (E) used for large shades only. (J) Round cotton lamp wick on which the box or case rests.

-fig. viii-



Finished box with the base or pedestal showing the broad bevelled edge on which a descriptive label can easily be pasted.

NOTES ON MOUNTING THE WAR COLLECTIONS
AT THE ARMY MEDICAL MUSEUM

BY CHARLES F. SILVESTER

*Captain, Infantry, U. S. A.**From the Department of Pathology, Army Medical Museum,
Washington*

- I. MOUNTING THE SPECIMEN
- II. RESTORING COLOURED SPECIMENS
- III. THE TYPE EXHIBIT
- IV. PREPARATION OF MISSILES

The remarkable advances in methods of warfare during the great World War have resulted in the development of new pathological conditions and diseases. The museum man must keep abreast with these changes and record them in an understandable and permanent manner. He must be alive to all technical branches of arts and sciences and discover their application to his particular need.

The following brief notes cover a few of the difficulties encountered in mounting the war collections. The question of preserving fluids and of labelling are dealt with elsewhere in this journal.

I. MOUNTING THE SPECIMEN

The specimen should be dissected or sectioned to show not only the wound or pathological lesion in question, but in such a manner as to bring out the anatomical relationships, and, where possible, to suggest to the surgeon the best method of treatment. A section of a lung a few inches square may show a given pathological condition, but it is extremely doubtful whether it would convey to the student, in the broader therapeutic sense, the ideas that would be stimulated by an entire organ properly displayed.

Naturally each specimen presents its own particular problem when it comes to the question of display and mounting. The object sought is to have each exhibit stand out in clear-cut outlines, with as little emphasis as possible on the jar and mounting. The majority of specimens may be mounted on frames made from glass rods and wedged against the front of the jar with hard sheet rubber, bent the proper shape to take up the space between the specimen and back of jar. The elasticity of the rubber sheets,

when bent in one or two open curves, not only holds the specimen in place but takes up any vibration and prevents injury in handling. The back and side of the jar are then painted black to take the emphasis off the jar and make the specimen more pronounced. Paraffined silk thread is used to fasten the specimen to the frame. The thread should be concealed and of the same colour as the background. The specimen may also be held to the front of the jar by making a three-legged frame of glass rod and cutting off the legs to occupy the exact space between the object and the back of the jar. Where the back of the jar is to be painted black, however, the hard rubber sheets are much better. They are obtainable in any thickness and can readily be bent and shaped by the application of heat.

II. RESTORING COLOURLESS SPECIMENS

The question of preserving and restoring natural colours to pathological specimens has long been, and is to-day, one of the greatest problems presented to the museum worker.

Several methods of restoring colour to old pathological specimens have been published. They have proven uniformly valueless. When the colour has gone from a specimen, through age or bad treatment, it has been the experience of the writer that by adding fresh colour only is one able to restore it. The ordinary methods of restoring colour are of no value in this type of specimen.

Many old and colourless specimens have been completely restored by treating the surface with fresh blood. The method is somewhat severe and for this reason is not applicable to all classes of material. The difficulty lies in getting the fresh blood to stick and stick in the proper place.

Fresh beef or dog's blood is drawn off and shaken up with 5 grams of Boracic acid or 5 cc's of strong formaldehyde to each 100 cc's of blood and is placed in a tightly corked bottle for use when desired. The formalized blood is better, it, however, coagulates in the bottle and must be renewed more often. The method is especially adaptable to wounds of the extremities, muscle tissue, livers, and intestines, or any specimen where a more or less uniform blood colour is desired. The specimen to be treated is washed in warm water, dried with blotting paper, and placed before an electric fan until the surface begins to dry. The surface of the specimen is then painted with the blood, using the proper discretion, laying it on thick in certain places and thinning it out in others. The blood is allowed to soak in and the specimen is placed under an electric fan until the surface dries. The surface



THE TYPE EXHIBIT, Army Medical Museum, Washington, D.C.

FIG. I.

Specimens arranged in logical order on shelves behind holes cut to size in false cardboard front.

of the specimen may be treated with 95% alcohol after the blood is applied, this hastens the drying and has a tendency to coagulate the blood in position. If this is done care should be taken in order not to wash away the blood. It is then washed in running water for two or three hours and placed into the final preserving agent. The drying of the blood on the surface of the specimen is absolutely necessary to insure permanency. Specimens treated in this manner more than eight months ago have retained their bright colour.

III. THE TYPE EXHIBIT

Where a sufficient number of specimens exist illustrating a certain disease or pathological condition, an initial exhibit should be arranged telling the story of that particular type of lesion or disease. This exhibit should be logically arranged and clearly labelled, with guide lines running from the classification label to the specimen illustrating that particular point. A very effective display along these lines may be arranged by making a false front for the case out of a sheet of cardboard. Windows are cut in the cardboard to fit each jar and the sheet is fastened flush with the fronts of the jars. The cardboard is painted a neutral colour and the descriptive or classification labels are stenciled in position on the false front.

IV. PREPARATION OF MISSILES

Many specimens of battle injuries contain foreign bodies, rifle and machine gun bullets, fragments of high explosive shells, grenades, etc. These require special treatment if they are to be preserved with the specimen. A very small fragment of metal left for any length of time in the preserving fluid, not only discolours the fluid, but in time completely oxidizes and often renders the specimen worthless for museum purposes. The missile should either be reproduced artificially in plaster or wax, coloured to imitate the original, or the metal specially treated to prevent corrosion. In specimens dissected or sectioned to show the position or path of the foreign body, the fragment is carefully removed, treated, and placed back in position. The treatment consists in placing the missile in boiling soda water for a few moments, removing, rinsing in clear water and thoroughly drying by heating with the Bunsen burner. This boils out all moisture and opens up the pores of the metal. It is then, while thoroughly hot, placed in a dish of melted paraffin and allowed to boil a minute or two, after which it is removed with the paraffin adhering to the surface and again thoroughly heated with the Bunsen flame. In this

manner the paraffin is driven into the pores of the metal. It is then placed in the melted paraffin, again allowed to cool partially, then removed, the surplus paraffin shaken off, and it is allowed to completely cool. It is then carefully placed in position and held there by glass pins or fine thread. Foreign bodies treated in this manner more than a year ago have remained in the preserving fluid without change. This process has been found to be much simpler and easier than constructing an artificial missile.

COLOUR PRESERVATION AND MOUNTING

Retrospect: PRESERVING FLUIDS FOR GROSS PATHOLOGICAL SPECIMENS WITH REVIEW OF LITERATURE

CHARLES F. SILVESTER

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*From the Department of Pathology, Army Medical Museum,
Washington, D.C.*

The question of preserving natural colour in gross pathological specimens has long held the attention of the museum worker and has resulted in the publication of a vast number of formulæ, many of which can lay claim neither to originality nor merit.

In this brief *resumé* of the various preserving fluids with which the writer has had experience, only those formulæ are given which are of historical interest or which appear to possess some especial or particular advantage. No claim is made that all of the so-called good preserving agents have been brought to attention.

A study of the literature would seem to reveal the fact that some of the authors had simply juggled the chemicals in other published formulæ and had thereby obtained a solution which would make specimens look like rainbows and last forever.

In 1896, Melnikow-Raswedenkow, Jores, and Kaiserling independently published formulæ for the preservation of colour in pathological specimens. That of Melnikow-Raswedenkow was published in January, Jores in February and Kaiserling in July. Since this initial research very little advance has been made toward the preservation of natural colours.

The process familiarly known as "Kaiserling's" or Melnikow-Raswedenkow's process stands to-day as the most widely used and

probably the best method for the preservation of gross pathological specimens. The solutions are made up as follows:

I (K 1899)	II (M-R)	III (M-R)
Potassium Acetate 385 gr.	Restore color	Potassium
Potassium Nitrate 145 gr.	with alcohol	Acetate ... 30 gr.
Formalin 800 cc.	to 95%	Glycerine... 60 cc.
Water 4,000 cc.		Water 100 cc.

This formula will be referred to in this paper as the "M-R Solution."

The advent of chloral hydrate and of arsenious acid were two distinct advances in the preservation and permanency of natural colours—the chloral hydrate because of its brilliant effects on the blood and the arsenious acid for its lasting qualities as a final preservative.

The following tables show some of the more important preserving agents given in their chronological order:

Name	I	II	III
Grawitz, P. 1887	Sodium Chloride 150 Sugar 40 Boracic Acid 30 Potassium Nitrate ... 20 Water 1,000-2,000		One Solution Only
Melnikow- Raswedenkow January, 1896	Strong Formalin	Alcohol 95	Glycerine 60 Potassium Acetate ... 30 Water 100
Jores February, 1896	Sodium Sulphate 2 Magnesium Sulphate . 2 Sodium Chloride 1 Water 100 Formaldehyde 5-10	M-R	Glycerine 100 Water 100
Kaiserling July, 1896	Potassium Acetate ... 3 Potassium Nitrate ... 1 Formalin 75 Water 100	M-R	M-R
Melnikow- Raswedenkow 1898	Formalin 100.0 Sodium Acetate or ... 3.0 Potassium Chlorate .. 0.5 Water 100.0	Weak Alcohol up to 95%	Glycerine 60 Potassium Acetate 30 Water 100
Kaiserling 1899	Potassium Acetate ... 85 Potassium Nitrate ... 45 Formalin 800 Water 4,000	M-R	M-R

Name	I	II	III	IV	
Puppe, G. 1899	K	M-R	III M-R	Glycerine 250 Water 250 Alcohol Absolute. 100	
Pick, L. 1900	Water 100 Carlsbad Salts, artif. 5 Formalin 5	M-R	M-R		
Heidenreich, L. L. 1903	Glycerine 100 Water 50 Mixture of 2 parts Methyl Alcohol and 3 parts Formalin. 7 Chloral Hydrate. 10-20		One Solution only.		
Nastyukoff, M. M. 1908	Cresol 2 Potassium Nitrate . 10 Glycerine 200 Water 800		Kerosene or Vaseline Oil. (Russian Mineral Oil)		
Schorr 1911	K 1899.....	M-R	III Sodium Chloride... 10 Alcohol..... 15 Glycerine 100 Water..... 100	IV Mount dry Hermeti- cally sealed.	
Melnikow- Raswedenkow 1911	Sodium Acetate.... 3.0 Potassium Chlorate. 0.5 Formalin 10.0 Water..... 100.0 (Kali Chlorici)	Alco- hol 95	Glycerin 60 Potassium Acetate... 30 Water 100		
McFarland and Case 1911	K 1899	M-R	III M-R	IV Strong Glycerine	V Russian Mineral Oil.
Jores 1913	Carlsbad Salts 5 Chloral Hydrate .. 5 Formalin 5 Water 100		M-R		
Frost, R. L. 1913	K 1899	M-R	Sodium Fluoride 80 Chloral Hydrate 80 Potassium Acetate 160 Cane Sugar 3,500 Sat. Thymol Water 8,000		
Delepine, S. 1913	Sodium Sulphate .. 20 Formaldehyde 100 Water 900	M-R	Sat. Arsenous Acid Water 4,000 Glycerine 6,000	IV Gold Label Gelatine 425 Sat. Arsenious Acid Water ... 1,500 Glycerine 5,760	

Name	I	II	III
Klotz, O., and MacLachlan,	Carlsbad Salts, Modified 125 Chloral Hydrate...125 Formalin 125 Water.....4,000		Cane Sugar 3,500 Potassium Acetate. 160 Chloral Hydrate .. 80 Thymol Water.... 8,000
Haythorn 1915	Klotz and MacLachlan		Arsenious Acid 40 Potassium Acetate. 160 Cane Sugar..... 3,500 Water 8,000
Klotz, O., and Colburn 1916	Klotz and MacLachlan		Carlsbad Salts 2.5 Chloral Hydrate ... 1 0 Formalin 0.5 Water 100.0

The following four methods have been found to produce good results. They are recommended for the preservation of colour.

1st, MELNIKOW-RASWEDENKOW'S SOLUTION, AS MODIFIED BY KAISERLING

I (K 1999)

Potassium Acetate	85 grms.
Potassium Nitrate	45 grms.
Formaldehyde	800 c.c.
Water	4,000 c.c.

II

Restore in 95% Alcohol

III

Potassium Acetate	30 grms.
Glycerine	60 grms.
Water	100 c.c.
Carbolic Acid	$\frac{1}{4}$ c.c.

Saturated thymol water may be used as a preservative in place of Carbolic Acid.

2nd, JORE'S MODIFICATION OF PICK-M-R SOLUTION

I

Chloral Hydrate	5 grms.
Carlsbad Salts, Artificial.	5 grms.
Formaldehyde.....	5 c.c.
Water	100 c.c.

Use formula of Klotz and MacLachlan for making artificial Carlsbad salts.

Sodium Sulphate	22 grms.
Sodium Bicarbonate	20 grms.
Sodium Chloride	18 grms.
Potassium Nitrate	38 grms.
Potassium Sulphate	2 grms

II

Development in alcohol is not necessary with this fixing solution as the colour is not lost.

III

Potassium Acetate.....	30 grms.
Glycerine	60 cc.
Saturated thymol water	100 cc.

This modification has been found to produce excellent results, particularly for intestines or smaller organs which harden quickly.

3rd, CHLORAL HYDRATE, ARSENIC METHOD

I

Chloral Hydrate.....	50
Sodium Sulphate.....	12
Sodium Bicarbonate.....	10
Sodium Chloride	9
Potassium Nitrate	19
Formaldehyde	100
Water	1,000

This formula is practically the same as in the modification above. The formalin percentage has been increased. Rapid and thorough fixation are requisites for the best colour results.

II

Thoroughly wash in running water from 3 to 15 hours and place in solution No. III. Specimens which have remained a relatively long length of time in the fixing bath require to be developed in 95% alcohol.

III

Potassium Acetate	300
Glycerine.....	300 to 600
Saturated arsenic water	1,000

Saturated arsenic water is made by boiling an excess of trioxide of arsenic in water for two hours. Allow to cool and filter or decant off the clear liquid.

This third method has been largely used by the writer. The colour results are brilliant and the keeping qualities are better than in any other combination thus far used.

Following are some points which must be observed if the best results are to be obtained:

Fixation.—The specimens must be fresh. They are taken direct from the autopsy, rinsed in normal salt solution and placed in the fixing fluid for from 6 hours to 5 or 6 days. It is absolutely necessary to have the specimens thoroughly fixed. They should not remain, however, in the hardening solution beyond the point of thorough fixation. This is important if the best results are to be obtained. A section of intestine, filled with the solution or slit open, should be well fixed in six hours, while a large bulky organ may take as many days. Whenever possible hollow organs should be filled with the solution and large organs injected. A relatively large quantity of fluid should be used, at least ten times the volume of the specimen. The specimen should be laid out and held in natural position showing correct anatomical relationship. The fluid should be changed if it becomes dirty or if the specimen is not fixing properly. No metal of any kind should be allowed to come in contact with the fixing agent. When removed from the fixing bath the specimen should be washed in running water for two or three hours for the first method or from three to fifteen hours for the second and third methods. At this stage the specimen is trimmed up, sectioned, fresh surfaces are cut and the organ is dissected in correct form for final mounting.

Developing.—The excess of water is drained from the specimen, it is rinsed in 80% and placed in 95% alcohol until the blood colour comes out a brilliant red. This will take from a few minutes to two or three hours. The alcohol should be kept up to near 95%, the action is much quicker and the results are more brilliant. From the alcohol the specimen is thoroughly washed in running water for from three to fifteen hours depending upon the size and density of the organ. Large objects containing foreign bodies should be X-rayed in order that metal parts may be removed without injury to the specimen.

Final Preserving Fluid.—Absolute cleanliness is essential at this stage of the procedure. The specimen should be changed to clean solutions once or twice, where it must remain for at least a week before it is finally mounted. Foreign bodies, containing metal, which are to be mounted with the specimen, must be especially treated before they are placed in position (See "Notes on Mounting the War Collections at the Army Medical Museum" published in this Bulletin). Seekers or

pointers should be made from coloured glass rods or from paper dipped in hot coloured paraffin.

4th, DELEPINE'S ARSENIOS ACID-GLYCERINE-GELATINE METHOD

Where gelatine mounts are preferred, this method, somewhat modified, has been found to produce excellent results. The specimen is hardened in one of the three fixing agents given above. These have been found to produce better colour results than Delepine's fixing solution. The specimen is then developed in 95% alcohol, if necessary, washed in water and run through the glycerine and gelatine solutions for final mounting.

Solution A—Arsenious Acid Glycerine

Saturated Arsenious Acid water,—made by boiling an excess of arsenic in water for two hours, allow to stand for 12 hours, filter or decant	4,000 cc.
Pure Glycerine	6,000 cc.

Specimens are left in this solution until they are thoroughly penetrated, two or three days, or longer, provided they do not show marked evidence of shrinkage. They are then placed in "Solution B".

Solution B—Arsenious Acid Glycerine Jelly

Gold label gelatine, (weigh dry, then wash)	425 grms.
Saturated arsenic trioxide water (see Solution A)	1,500 cc.
Heat until dissolved and add pure glycerine (hot)	5,760 cc.

Mix this solution thoroughly and allow to partially cool, add the whites and broken shells of six eggs, mix again, and maintain at a temperature of 90 C. for two hours or until the albumen has coagulated. Filter through fine muslin, absorbent cotton and filter paper, and store in air tight jars until desired. This is the final mounting medium. The specimen should be placed in the warm medium in exact position for display. Square glass jars have been found to be the best for final display for the reason that they can be hermetically sealed.

The entire jar need not be filled with the gelatine. Place the jar face down in a pan of the melted mass containing the specimen, slide the specimen in place and wedge it against the face of jar. Raise the jar from the solution holding it in a horizontal position and retain just enough of the mass to cover the specimen. Allow the mass to coagulate, then place the jar in an upright position, fill with "Solution A" and hermetically seal. Care should be

taken that there are no bubbles or air holes between the specimen and the face of the jar.

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PERSONAL MODIFICATIONS IN THE TECHNIQUE OF THE KAISERLING METHODS OF COLOUR PRESERVATION

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Like possibly many others, at one time I was very skeptical as to the ultimate use of Kaiserling. Results were not uniform and far from satisfactory, owing, I have since found, to unskilful technique, together with the improper quantity of the various salts used. There are to my knowledge at the present time ten different formulæ in use, each one giving various results.

Kaiserling for ordinary pathological and anatomical preparation, where the colour of the red blood cell is the base to be preserved, gives by far the best results. With this exception, however, that if any of the faint yellows or greens, due to bile staining or other causes, require to be kept, one of the chloral hydrate fluids, preferably Klotz, gives excellent results, with Kaiserling No. III as a permanent preservative.

Specimens must be obtained fresh from the autopsy or operation and not allowed to soak in water for more than a few moments. Only the superfluous blood should be washed away, remembering that the one colour available for preservation lies in the hæmoglobin of the red blood corpuscle, and that this therefore, must be preserved. The basis of the methods of colour preservation which are in my judgment to be recommended, lies in the chemical change produced by the action of formaldehyde upon the hæmoglobin of the red cell and its subsequent fixation as the red alkaline hæmatin by alcohol.

The proper laying out of the specimens in the No. I solution it is necessary to enlarge on. No cloth, metal pins, or paper must be allowed to come in contact with them. Cotton wool to hold in shape and stretching on glass frames with cotton thread is all that is necessary. Large bodies of fresh fluids must be used.

After careful comparison both in Europe and here, the following process has been found by us to give the best results.

KAISERLING'S SOLUTION No. I

Pot. acetate	170 gm.
Pot. nitrate	90 gm.
40% formalin.....	1,600 cc.
Water	8,000 cc.

Care should be taken to use only first class chemicals. Potassium nitrate, Merck's pure powder, and potassium acetate, U.S.P. The formalin should be as free of formic acid as possible. The reaction should always be taken with litmus paper and, if the solution is strongly acid it should be neutralized with caustic soda (Shore).*

The length of time the specimen stays in Kaiserling's first fixation fluid has caused a great deal of comment; I consider it of secondary importance to thorough hardening. The specimen should be fixed in such a way that no blood will ooze out when firmly pressed between the fingers. In fact good colour results have been obtained in specimens that have stood from two to four months in the No. I solution. This is, of course, in exceptional cases. Intestine should not be left in for more than ten to twelve hours; other specimens of organs from one to five days. But in all instances they must be thoroughly fixed.

Great care must be taken to wash the specimens thoroughly in running water after removal from this solution.

KAISERLING NO. II

Ninety-five per cent. alcohol (ordinary methylated spirits will do) may be used at once without the intermediate stage of 80% alcohol, recommended by Kaiserling. The specimens must be left here until the natural colours, which have disappeared under the action of the formalin in the first solution, return, the process being watched in the same way as is a photographic plate.

The alcohol should not be allowed to go below 80%. To avoid this the specimens should be transferred to a second alcohol of the original strength. The time in which the specimens remain in the alcohol varies according to the character of the particular tissue.

In this stage again the specimens must be carefully washed in water, no traces of the formalin or alcohol used in the first and second solutions being carried on to the final fluid. If either the alcohol or the Kaiserling No. III solution used smell at all of either formalin or alcohol they must be thrown away. This is absolutely necessary.

When specimens have been left in spirits for too long a time much colour can be restored by leaving them in equal parts of Kaiserling No. III and glycerine for 24 hours, allowing for the amount of glycerine already in your Kaiserling fluid.

*Shore: *Journ. Path. and Bact.*, April, 1921.

KAISERLING No. III

Pot. Acet.	4 lb.
Glycerine	2,000 to 4,000 cc.
Water	10,000 cc.
to which 20 cc. carbolic acid may be added as a preservative.	

In preserving veterinary or comparative anatomy specimens Kaiserling is not satisfactory, the best results I have had, have been with Klotz, increasing possibly the formalin to 6% then running through the alcohol and preserving in Kaiserling III.

While in the days to come we may possibly improve upon present methods of colour preservation, it seems to me that this can only be done by using special fluids for each particular lesion. In microscopic technique various stains are used to show the particular conditions wanted, yet we expect these same conditions to be shown in the gross with only one fluid, namely, Kaiserling.

When Kaiserling material is to be used to pass around a class, care must be taken not to allow the surface to dry, or the fluid to be infected with mould. One infected jar will spread through many others and necessitate putting them through No. I and No. II solution as you would a fresh specimen.

THE USE OF ANTISEPTICS IN MUSEUM FLUIDS

SAMUEL HIRSCHFELD, M.D.

A systematic examination of approximately one thousand specimens in the pathological museum of the College of Physicians and Surgeons showed that seventy-five specimens were spoiled for demonstration purposes because of a general clouding of the preserving fluid, or from the growth of surface moulds. In some specimens there was a diffuse clouding of the fluid with considerable sediment, but in most of the affected jars the sedimentation was slight. These observations led to an investigation of the cause of the clouding and to some experiments aimed at finding a suitable modification of the preserving fluid to prevent the clouding. Practically all specimens had been preserved by the Kaiserling method with the following as the permanent solution without the addition of any antiseptic:

Glycerine	200
Potassium acetate	100
Distilled water	1,000

From the jars which had a sediment, a hanging drop preparation showed moulds and yeasts. Cultures were made from twenty-five clouded fluids on plain agar and glycerine agar, and twenty-one growths were obtained. Twelve of the growths were bacteria of the micrococcus catarrhalis, staphylococcus, and B. subtilis groups, which were essentially the same types as those obtained by exposing an agar plate in the room where the museum specimens were kept.

On four tubes a pure culture of yeast was grown.

On two tubes moulds grew.

Clear Kaiserling II solutions were inoculated with the organisms grown from the infected fluids, and in each of the jars a general clouding of the fluid occurred, giving it exactly the same appearance as the affected museum fluids.

It was therefore concluded that moulds, yeast, and various types of bacteria are able to grow in Kaiserling II, with a consequent general clouding.

A series of experiments was then carried out to determine an effective antiseptic which would not affect the colour of the specimens and would be cheap enough to be of practical use.

The antiseptics used were added to solutions of Kaiserling II which contained pieces of tissues taken from the infected fluids. Sets of solutions were prepared containing the following:

1. Tissue from fluid infected by moulds.
2. Tissue from fluid injected by yeasts.
3. Tissue from fluid infected by saprophytic bacteria.
4. Tissue from fluid infected by moulds, yeasts, and saprophytic bacteria.

In the following table the antiseptics used are given with the findings with respect to solubility, antiseptic value and cost:

	Insoluble with clouding	Antiseptic proper- ties	Approximate cost per kilo	Approximate cost per 1,000 c.c of mu- seum fluid
Alpha-naphthol	+		\$7.00	?
Beta-naphthol	+		2.50	?
Thymol		Slight	7.00	?
Camphor		Slight	2.75	?
Dichloramine-T	+			
Borax 5%*		Slight	.50	\$.25
Copper sulphate 1:1,000		Slight	5.00	.05
Mercury bichloride 1:10,000		Slight	3.25	.003
Zinc chloride		Slight	1.25	.12
Phenol 2%		Good	1.75	.035
Creolin 5%	+	Fair	2.25	.112
Sodium benzoate 5%		Slight	2.25	1.12
Sodium salicylate .2%		Slight	1.25	.025
Sodium sulphite .5%*		Slight	.75	.037
Formalin 1:1,000		Slight	.90	.009
Formalin 1:200		Good	.90	.045
Alkaloids (such as Quinine Sul- fate)		?	Too ex- pensive	

It is seen that four of the substances used, alpha-naphthol, beta-naphthol, dichloramine-T, and creolin, are valueless for the purpose by reason of their relative insolubility in the medium and consequent clouding. In spite of the high cost per kilo of some of the chemicals, the amounts used are so small that the factor of cost does not need to be taken into consideration except in the case of alkaloids. Only two of the substances, formalin and phenol, prove to be effective antiseptics under the condition of the experiment.

To determine the comparative antiseptic value of these two substances the following experiments were done: Solutions of (a) Kaiserling II to which no antiseptic had been added, (b) Kaiserling II with phenol .2%, (c) Kaiserling II with formalin .5% and 1% inoculated with cultures from the various infected fluids.

*Because of their inexpensiveness, these antiseptics were tried out up to their point of solubility in the Kaiserling II.

If one or two cultures were inoculated into the solutions, all those with the antiseptic remained clear. When several cultures were inoculated into each solution, only the one that had formalin 1% remained clear.

We attempted to sterilize the infected specimens by immersing them in alcohol 95% or in formalin 5% for one hour before replacing the specimens in Kaiserling II, but it was found that a clouding of the fluid occurred within a day or two in either case.

A series of experiments was then carried out to determine the effect of phenol .2% and formalin 1.0% on the colour of the specimens. It was found that tissue in plain Kaiserling II maintained its colour slightly better than tissue in the Kaiserling to which either phenol or formalin had been added, and that phenol affected the colour more than formalin. The decolourization, however, in both cases was slight and was not regarded as sufficient to discourage the use of these antiseptics.

Testing the reaction of infected fluids with phenolphthalein as an indicator, it was found that all the fluids were acid, having an acidity ranging from 1% to 5%. Practically the same degree of acidity was observed to obtain in the non-infected fluids.

Conclusions.

1. Moulds, yeasts and bacteria grow in the Kaiserling II used as the final preserving fluid resulting in marked clouding.

2. Formalin added to the Kaiserling solution making a strength of 1% will prevent the growth of both bacteria and deep surface moulds, and will not affect the colour of the specimens to an appreciable extent.

3. The acidity of the fluid is not a factor in the clouding of the preserving fluid.

4. If the specimens are mounted promptly after fixation in well sealed jars which are not opened afterwards, it is probable that the addition of antiseptics is unnecessary. In the majority of laboratories, however, the care of specimens is such that the use of some antiseptic, preferably formalin, is advisable.

PERMANENT MOUNTING OF KAISERLING AND GELATIN-SURFACED SPECIMENS WITHOUT IMMERSION IN FLUID*

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In 1895, when transporting material from Philadelphia to Nashville, I learned that specimens, if kept moist, might retain their freshness for a considerable period, even in summer. A collection of hearts was shipped in a keg which leaked and from which all free fluid escaped; each specimen had been wrapped in a cloth and although they were without free fluid from early May until October, they were still in excellent condition. I did not at once realize the importance of this accidental finding,—as a matter of fact had quite forgotten it.

The experimental work upon which was based an article¹ already published, led us to recognize the practicability of mounting and apparently preserving Kaiserling preparations in rarefied air without submersion in fluid. Littlejohn² showed that toxicologic preparations (stomach after poisoning with carbolic acid or creosote, and similar specimens) could be preserved in tightly sealed jars without fluid. Delepine³ has developed a gelatin method of mounting, using arsenious-acid-gelatin, probably a very considerable improvement upon gelatin technic previously published⁴.

Within the last few years we have been experimenting upon mounts in moist air and without free fluid. As finally worked out the technic may be summarized as follows:

Specimens are first prepared according to the original Kaiserling method; no doubt any of the approved modifications would be equally successful. The specimen should be taken through two or three changes of the final preservative in order to rid it completely of any formalin or alcohol that may have been carried over. The specimen is properly oriented and securely attached to a

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

¹*Journal American Medical Association*, 1904, Vol. XLIII, p. 441

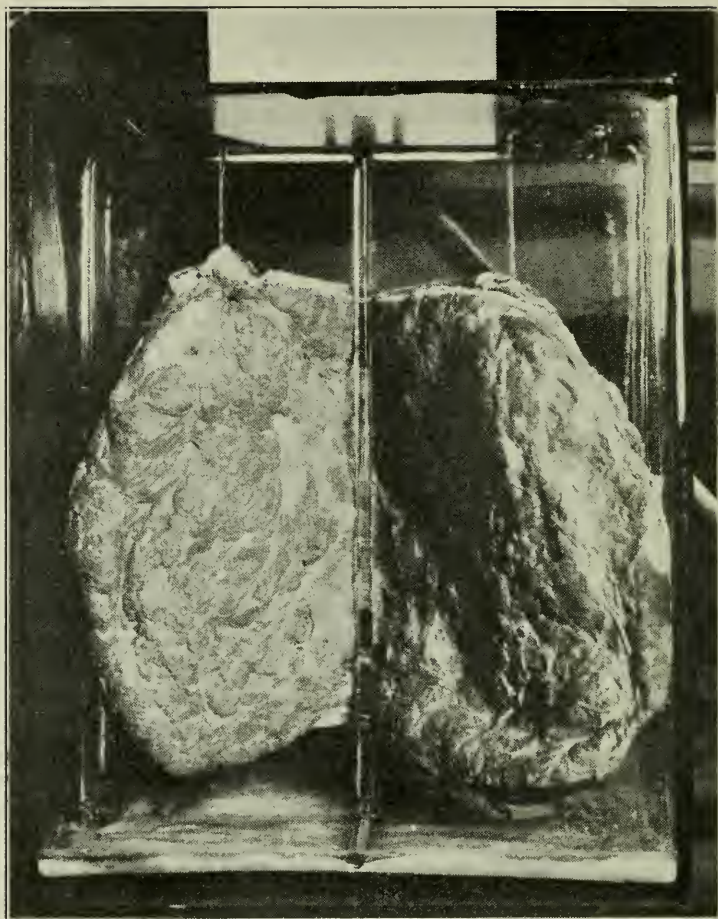
²*Journal of Pathology and Bacteriology*, 1902, VIII, p. 369

³*Journal of Pathology and Bacteriology*, 1914, XVIII, p. 478.

⁴*Publications from the Laboratories of the Jefferson Medical College Hospital*, Vol. II, 1905.

glass frame; rigid specimens, for example, a gangrenous leg, require no frame. A jar of the proper size having been thoroughly cleaned, absorbent cotton to a depth of 1 to 2 cm. depending upon the size of jar, is evenly distributed on the bottom, and moistened with final Kaiserling preservative. The amount of fluid should be sufficient to moisten the cotton but not enough to flow when the jar is laid upon its side. In addition to serving as a material for retaining the humidifying solution, the cotton acts as a cushion for the frame and lessens the chances of breaking. The specimen is then carefully mopped dry; absorbent cloths held to the dependent portions absorb the last drop of moisture. If it is desired that the surface of the mount be bright and glistening, like many fresh specimens, a coating of gelatin may be applied. I have not tried Delepine's gelatin but am inclined to believe that it is probably better than the formol-gelatin originally recommended. The prepared specimen is then placed in a jar the lid of which is sealed with asphaltum cement; I found none better than the McGill formula⁵. At first, difficulty was encountered in maintaining a seal as, during very warm weather, expansion of the contained air lifted the lid; there was also considerable condensation in cold weather; these objectionable features were so discouraging that it looked as though the method must be abandoned. It was found, however, that by heating the jar the contained air could be sufficiently rarefied and since the adoption of this plan no difficulty from condensation has been encountered, nor has any seal broken. The jar can be heated by carefully flaming the outside, using a large torch for the purpose; by this method, however, some jars break and in addition, it is uncertain. The best plan is to set the jar in water the temperature of which exceeds any that the museum is likely to reach; 60° C. is adequate. The water need not come to the top of the jar. If the jar is placed in a larger container, sink or bucket, or other vessel of suitable size, two or three thicknesses of cloth thrown across the top facilitates warming. During all this time the small hole in the lid has been left open, otherwise the mount has been completed and the jar has been sealed tightly. As soon as the jar is uniformly warm it is removed from the warming bath, any moisture around the hole in the lid is wiped off with a dry cloth and the hole flamed and sealed. At first we experienced some difficulty in maintaining the seal. We tried an ordinary coverglass and balsam but as the lid remains warm some little time after contraction begins the balsam was usually forced in and air entered. Finally, a small plug of pine

⁵*International Assoc. Med. Museums*, Bull. V, 1915, p. 87.



FIBRO-LIPOMA OF THIGH

Photograph of specimen in jar, showing incised surface. Specimen was mounted and sealed June 1st, 1917, since which date it has received no attention. Cotton pad saturated with final Kaiserling shown at bottom of jar. This pad, in addition to offering sufficient absorption to adjust humidity and prevent condensation on inside of jar, acts as a cushion to the supporting glass frame which otherwise might readily be broken. The threads supporting the specimen were not anchored securely; consequently some sagging has occurred. This inadequate suspension resulted from failure to recognize a need for greater security, due to the fact that the entire weight of the specimen (about 4 kilo) uninfluenced by buoyancy of fluid, must be borne by the suspending devices.

fitted to the hole in the lid was dipped into hot asphaltum cement, and while still warm forced into position. The plug is then cut even with the lid. All our specimens are carried through with an aluminum accession tag 3 cm. by 2.5 cm., on which is stamped the number of the specimen. Formerly we attached this tag to the specimen or to the frame and sealed it inside the jar; occasionally the number corroded and sometimes it was difficult to read. During the last two years we have poured asphaltum compound over the plugged hole in lid of jar, and on this the heated tag is forced into position; this we found practical and convenient.

At the time this paper was presented⁶ several specimens had been preserved by this method for five years,—all are in good condition. The accompanying photograph of a large lipoma of the buttock, taken after more than four years, shows how satisfactory the method has been, even when applied to this rather difficult subject. Our experience with large fatty masses has been that the fat gradually comes out, clouds the fluid or collects on the surface. One of the difficulties shown in the fatty tumour is that we did not realize how secure the suspending anchorage must be. The absence of fluid and consequent buoyancy, make the drag on the suspending devices very much heavier than in fluid mounts. Heavy specimens should be securely supported by braided silk or linen of good size, that will not cut through, and if the specimen is soft the thread may be anchored in position by the use of glass rods passed through the specimen very much as skewers are thrust into meat. As these rods are always shorter than the diameter of the specimen they may be pushed inside and completely concealed.

For teaching purposes and particularly for demonstration to students, mounts without fluid are much lighter to handle, less subject to breakage, and are better displayed than mounts in fluid. These advantages have been found especially true of sections of ovarian cysts and similar light specimens of large bulk; half an ovarian cyst 30 cm. in diameter, showing small papillary growths in its interior, is well preserved after three years; in fluid it was difficult to see the details of the lining membrane of the cyst; in the dry mount all details are easily recognized. Reduction in weight is striking; fluid necessary to fill the jar containing the fatty tumour weighs over 19 kilos., that necessary to cover a gangrenous leg 14 kilos. Obviously the economy is proportionate.

Gall-bladders, kidneys and urinary bladders and other specimens containing calculi, have always presented insurmountable

⁶International Association of Medical Museums, American Section, April, 1920.

difficulties in fluid. Most calculi disintegrate in any medium with which I am familiar. Foreign bodies, particularly nails, especially specimens of bronchi containing such bodies, never make satisfactory wet mounts. Before the introduction of the dry method, the problem had been unsatisfactorily attacked by placing calculi in glass tubes which were sealed and attached to the frame or to the specimen in the jar. This enabled the student to observe the specimen and to see the foreign body, but not to see both in their proper relation. Recently stones, gall-bladders and kidneys have been mounted dry; stones are held in place by threads; although some of these mounts have been under observation for more than a year and are in good condition, I do not care to speak with assurance of the permanency of the method. It is quite possible that the small amount of preservative reaching the stone or foreign body may, in time, lead to disintegration or corrosion. The dry or moist-chamber method is readily applicable to Petri-dish and clock-glass mounts. Some thin specimens, for example, slabs and membrane, may be cemented to plate glass, using gelatin or agar; the surface to be viewed is placed next to the glass and the back covered by clock-glass or Petri-dish. Instead of plate-glass it is now proposed to try large glazed tile and cover the mounts with watch- or clock-glasses or Petri-dishes.

Because of expense and difficulty in securing satisfactory rectangular jars we are at present conducting some experiments in concrete backing for specimens. The purpose is to mount specimens dry, or in gelatin, on plate glass, and to back the entire glass in water-proof cement. Our experiments are not sufficiently advanced to report at this time, but it is believed that the difficulties so far encountered may be overcome.

A METHOD OF MOUNTING WET SPECIMENS

DR. ALEX. GIBSON

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Winnipeg, Manitoba*

A principle made use of to only a slight extent in the mounting of wet specimens is the employment of a background which forms a useful colour contrast to the main colour of the specimen itself. In most cases one wishes to view a specimen from every side, but it is sometimes convenient to attach it to a mount. An easy and convenient method of doing so is noted as follows:

Take a sheet of blotting paper and immerse it in a dye of the desired tint. Allow it to dry flat, cut in the size and shape of the mount required. The thickness necessary will vary with the weight of the specimen. Next, immerse the mount in a bath of melted hard paraffin and allow it to dry. It is then an easy matter to attach the specimen to the mount by the use of a curved needle and ordinary linen thread. The sutures are passed from the back of the mount, and all knots are tied on the back so that, as viewed from the front, the specimen does not show any obvious attachment.

Cardboard can be used for the same purpose instead of blotting paper, but it requires to be immersed in the paraffin bath until it is completely saturated, otherwise moisture will penetrate between the layers of cardboard from the sites of the needle punctures. It is well, therefore, to seal these by touching with a drop of the melted paraffin after the specimen is fixed in position. Some of the aniline dyes, particularly eosin, fade on exposure to the light. So far as one knows, the preserving medium has no action on the mount itself.



SPECIMEN OF DOUBLE SUPERIOR VENA CAVA
ON PARAFFIN CARDBOARD MOUNT

A METHOD OF MOUNTING MUSEUM SPECIMENS WITH A MINIMUM OF FLUID*

JAMES MILLER, M.D., F.R.C.P.E.

Professor of Pathology, Queen's University, Ontario

Two difficulties present themselves to the makers of museums in these days—glass and glycerine, or in other words containers and mounting fluid. The question of glassware will probably gradually right itself and glycerine will come down in price but any mounting method which lessens breakages and diminishes the amount of fluid required is to be advocated. Large jars full of fluid are heavy and handled by students they are much more apt to be broken than if they contain little or no fluid.

Having to transport my museum overseas last summer I had to find the best method of packing the mounted specimens with a minimum of weight while retaining sufficient moisture to preserve the tissue. The method which I adopted was to draw off the glycerine mountant, introduce a small quantity of cotton wool moistened in the mounting fluid and seal up either with paraffin in the case of the smaller jars or tar and litharge in the case of the larger. In some cases only sufficient wool was introduced to cover the floor of the jar. The whole museum consisting of 250 specimens arrived in good condition. Some half dozen jars were cracked in transit but no specimen was destroyed either by drying or by mold. There is, of course, nothing so very astounding in this. It reflects credit upon Mr. Williams Waldie of the Royal College of Surgeons, Edinburgh, who removed the fluid and sealed the jars, but the interesting thing to my mind is that most of these specimens, although retained in the state in which they arrived after six months are in perfect condition as regards colour and appearance, and are in constant use for teaching purposes. Several of the medium sized and more valuable specimens were remounted in glycerine fluid but the greater number, and particularly the larger ones have been kept as they were. All the preparations had been fixed in Pick's fixation and passed through spirit into glycerine. Some had been given originally a surface coating of gelatine. These were particularly well preserved as regards appearance and colour, and I have no intention of using fluid in these jars again. It might be thought that dew

*Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

would form in the interior of the jars and dim the glass. That is not so if the fluid in the interior contains a considerable percentage of glycerine. The glass of the jars retains its transparency perfectly. Moreover, it is unnecessary to cover the top of the specimen with moistened wool. So long as there is a well wetted pad of wool at the bottom of the jar with a little free fluid over it there is no danger of any part of the preparation drying. Whether the method could be equally applicable to freshly mounted material I am not prepared to say. All the specimens dealt with in this way had been in mounting fluid for some little time.

Summarizing the results of this experience I would say that it is unnecessary to fill museum jars with mounting fluid. It is quite sufficient to have a pad of wool well soaked in glycerine mountant at the bottom of the jar. The best results are obtained with specimens which have a surface coating of gelatine. Such preparations when properly sealed may be regarded as permanent. They retain their colour and do not tend to dry. There is no danger of blood "colouring out" into the mounting fluid. This is a very distinct advantage as we have all had experience of specimens which will persist in colouring the fluid in which they are placed. This and the advantage of lightness in the case of large specimens and economy of fluid is the chief advantage of the method. It might also be added that the preparation has a more natural appearance as surface irregularities are more obvious.

THE PRESERVATION AND MOUNTING OF SMALL ORGANISMS BY THE FORMALIN-SUGAR METHOD*

F. SLATER JACKSON, M.D.

The formalin-sugar method, primarily designed by the writer for the preservation of fresh-water bryozoa¹ and later employed in a modified form for the preservation of insect larvæ and pupæ² has been found to give good results with other small organisms, and to suggest possibilities for a more extended application in the preservation and mounting of similar material and of delicate tissues.

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

¹Jackson, F. Slater. *The Preservation of Fresh-Water Bryozoa*. Trans. Amer. Microscopical Soc. Vol. 38, No. 3, July, 1919.

²Id. *A Method for the Preservation of Insect Larvæ and Pupæ*. Can. Entomologist, Vol. 51, No. 5, May, 1919, pp. 117-118.

The method is described in detail in the papers cited, and is briefly as follows.

For Aquatic Organisms (Fresh-water or Marine)

(a) Narcotization.

The specimens are placed in water (fresh or salt) in a vessel as small as is consistent with their full expansion, and a saturated solution of cocain or chloretone (the former is preferable) slowly added at intervals until expansion is complete and the organism no longer reacts to stimuli.

(b) Preservation.

The water is then gradually replaced by a solution of the following composition:

Cane sugar	10 parts
Formalin	2 “
Distilled water to	100 “

(For marine organisms salt water should be employed).

When the total fluid consists of about equal parts of water and preserving fluid, the specimens may be left undisturbed for half an hour or more. A portion of the mixture is then withdrawn and the preserving fluid gradually substituted, and finally the specimens are to be transferred to the undiluted formalin-sugar solution. This may be with advantage changed after the expiration of 24 hours, and no further treatment is necessary.

Various species of bryozoa prepared by this method over four years ago have since undergone no appreciable alteration and several small marine animals (nudibranch mollusca, tubularian hydroids, etc.) similarly treated, have so far satisfactorily preserved their form and colour.

II. For Insect Larvæ and Pupæ

The specimens are killed in the usual way in the cyanide bottle or with chloroform vapour, wet with 80% alcohol if the surface is oily or hairy, and then placed in the formalin-sugar solution, to which 5% glacial acetic acid has been added. After 24 hours in this mixture they are transferred to the original fluid, which should be changed at least once.

III. Mammalian Tissues and Organs

Pieces of tissue or small organs may be placed directly in the undiluted fluid, which should be renewed until free from discolouration due to blood, or in any case at least once. While originally designed for small organisms, the formalin-sugar method has re-

cently been found to give good results with mammalian tissues. The theoretical aspects of its application are discussed in the original paper, in which it is suggested that its efficacy is due to the adsorption of sugar on the formalin-fixed cells. The method, worked out on a theoretical basis, seems in practice to confirm this, and that the isotonic coefficient has been closely approximated, since the corpuscles of the blood of the frog and of the dog, mixed directly with an equal quantity of the solution, remain practically unchanged for many days.

Further experiments relative to the applicability of the method to mammalian organs are now in progress, with a view to determining the degree and permanence of preservation, the determination of which will obviously require further observation and time.

THE PRESERVATION OF AMYLOID SPECIMENS*

WILLIAM BOYD, M.D., M.R.C.P. EDIN.

*Professor of Pathology, University of Manitoba, Pathologist,
Winnipeg General Hospital*

Fresh amyloid material, such as a sago spleen, when stained with iodine in the autopsy room presents a striking and beautiful appearance. When preserved for some time in the museum, however, the distinctive features tend to disappear, and the specimen loses much of its value.

In an endeavour to retain the iodine stain in the tissue a certain amount of success has been attained. It is now eighteen months since the specimens were placed in the preservative, and the colour differentiation is as bright as it was on the first day.

The specimens were the spleen and kidneys of a boy who died from long-continued tuberculosis of bone. When treated with Lugol's solution in the autopsy room a beautiful picture of sago spleen was brought out, and the kidneys were seen to be dotted with little black specks like grains of pepper—the degenerated glomeruli. When, however, the specimens were placed in water, weak formalin, Kaiserling solution, Jores' fluid, spirit, chloral hydrate, or any of the ordinary preservatives, the iodine very soon dissolved out.

A number of different solutions were experimented with, but none were of any use until liquid petrolatum was tried. This

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

at once proved to be the solution we were looking for. It did not affect the iodine in any way, and the mahogany brown of the amyloid remained unaltered.

When the slice of iodine-stained organ was placed in the petrolatum a wonderfully beautiful iridescent sheen was produced on the surface, which persisted for about two days, and then slowly faded.

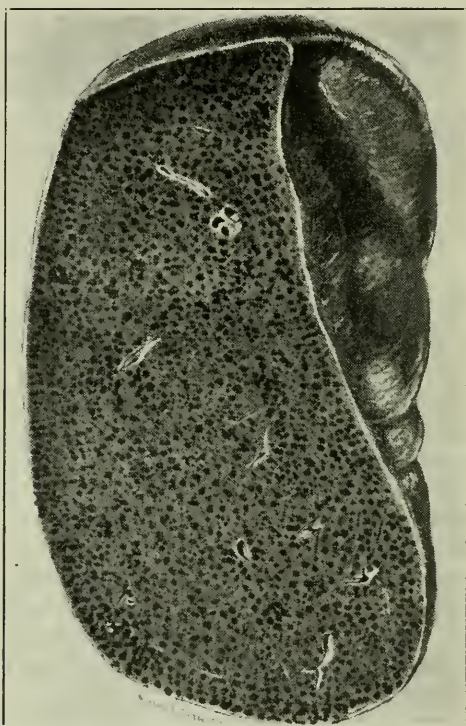


FIG. 1.

Water Colour Picture of Amyloid Degeneration of the Spleen (Sago Spleen) treated with Lugol's Solution immediately after autopsy, and preserved in Liquid Petrolatum. The Mahogany Brown Colour of the Amyloid remains unaltered.

The results have been very gratifying. The sago granules are still dark brown or almost black, and the glomeruli of the kidney are demonstrated in a wonderful manner. The specimens are made of much greater value for teaching purposes.

MUSEUM JARS AND LABELLING

MUSEUM JARS OF PORCELAIN AND TERRA COTTA*

R. J. TERRY

Department of Anatomy, Washington University

Terra cotta discus for sections.—With the revival in this country of the study of sections of the human body, the question arose as to what method was most suitable for permanent preservation and exhibition of the specimens. The value of a good series of transverse sections, permanently mounted, hardly calls for mention: the beginning student of human anatomy needs them; the practitioner in any field of medicine is grateful of the opportunity to consult them. They offer the most simple, complete, and at

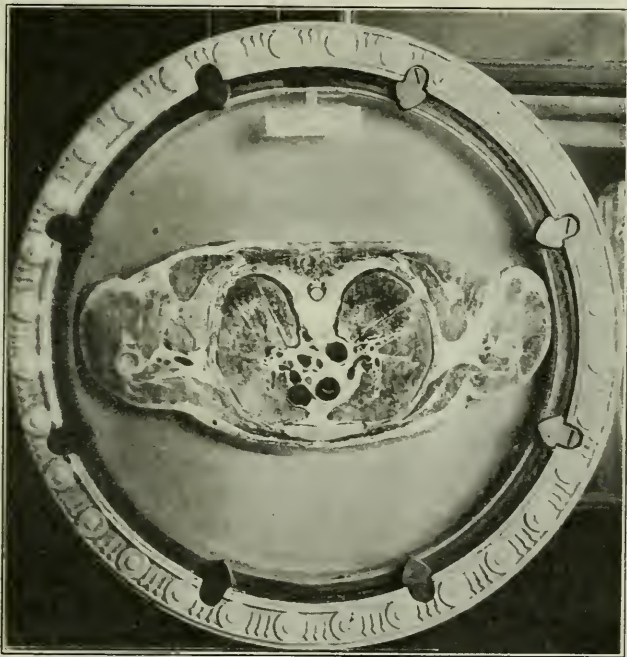


FIG. I.

Terra Cotta Discus covered by Glass Plate for Cross Section.

*Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

the same time, the most accessible exposition of anatomical parts and relations that has so far been attained. Although several forms of containers have been devised, there does not seem to be one available which meets the requirements for permanent mounting, minimum care and moderate cost.

Experiments made in this laboratory, have resulted in the manufacture of a type which, with some modifications, promises to fulfill the above conditions. Its present form is shown in Fig. 1. It will be seen to have the shape of a discus hollowed out into a shallow basin which is covered by a glass plate: the material is terra cotta well burned and glazed, with all visible surfaces tinted a neutral green. The dimensions outside are: diameter, 47 cm., depth, 10 cm.; the dimensions of the basin are, diameter, 36 cm., depth, 2.5 cm. which is the distance between the bottom of the basin and the top of a ledge which supports the glass plate. The latter is cemented in place upon the ledge and is further secured by a series of brass bolts passing through holes in the margin of the discus. A pair of lugs deeply notched to receive bolts are modelled upon the sides of the container, standing opposite each other, and serve for fastening it upon its support. A circular hole in one side permits filling the basin after the section is in place and the glass cover adjusted. Maintenance of the section in position may be accomplished in several ways; since this is not a problem peculiar to the kind of container here described, the various methods used need not be discussed. Sealing the glass cover securely and permanently is, of course, a serious problem arising from this type of container and is difficult of solution. What is wanted is a perfectly even surface of the ledge upon which the glass can lie and be secured by bolts without stress or strain. Unfortunately, terra cotta undergoes a certain degree of distortion in the burning, and this is manifested in a slight unevenness in the conformation of the upper surface of the ledge. Attempts to grind a true surface have been unsuccessful. The difficulty has, however, been met by setting the glass plate in a bed of sealing-wax poured upon the ledge, thus securing a water-tight joint. Application of the bolts still further fixes the glass in place. The basin is filled with formaline by the opening in the side. By means of the lugs, the discus is hung upon the wall, or bolted to a shelf which should be slightly inclined. The cost of the discus, including the glass plate and the bolts, was four dollars, in 1918.

Porcelain museum jar.—The rectangular museum jar has superseded the cylinder as a container for the exhibition of specimens chiefly because the objectionable phenomenon of distortion of the image produced in the latter is eliminated with a plane sur-

face. The rectangular glass jar, although a marked improvement in several respects on the older forms, does not yet fulfill all that is desired or even necessary. Annealing is frequently unsuccessful, especially of the larger jars, and as a result the glass cracks and eventually the container is lost. An opaque background is often needed in order to bring out sharply, delicate structures of many kinds; a background is sometimes necessary in order to see the specimen at all, where a strong light comes through the jar from behind. The opaque background can be improvised in several ways, but not so satisfactorily as by having a jar constructed with an opaque back. These two considerations led to our attempts to produce the museum jar now to be described.

This consists of a porcelain box provided with a glass front (Fig. 2). Outside dimensions of those now on hand are: height, 21.5 cm.; width, 14.5 cm.; depth, 8 cm. The walls and bottom, inside, slope somewhat toward the middle of the jar, from front to back. These sides are deeply grooved along their free margins to receive the edges of the glass plate which forms the front of the

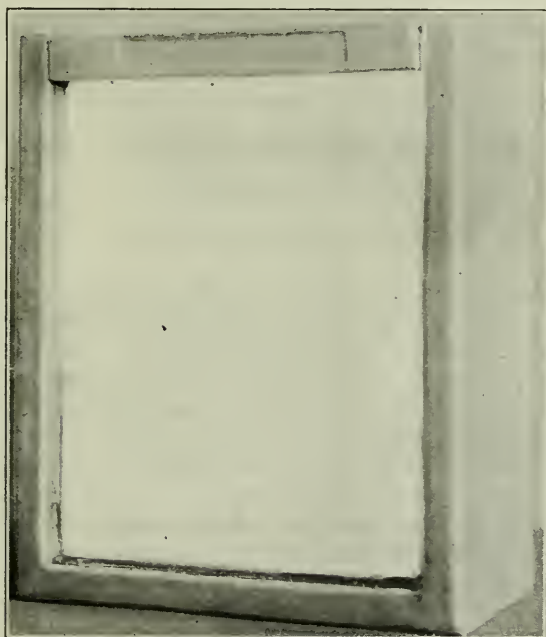


FIG. II.

Porcelain Museum Jar with Glass Front.

jar. After the specimen has been put into position the glass plate is shoved into the grooves from the top of the jar and fixed firmly in place by sealing wax. The lips of the grooves oppose any tendency to dislodgement of the glass from pressure of the fluid within. A little piece of moulding made of porcelain fits into the grooves at the top of the jar and completes the sealing. It is fashioned to hold the label. An opening in the top permits filling with formaline. The interior is coloured a soft white with almost no effect of polishing; the outside of the jar is tinted a neutral green; the surfaces are glazed. The cost of this jar in 1919 was one dollar and twenty-five cents.

The discus has been in use since the summer of 1919, a series of thirty-three having been placed in the dissecting laboratory and subjected to the kind of wear and tear which obtains where classes are at work. One glass plate has been cracked, probably by unequal pressure of the retaining bolts; three of the jars have required resealing. The porcelain rectangular jars have stood the test of about one year's use and meet fully the expectations of the plan. The results gotten from terra cotta and porcelain seem to be successful enough to justify our recommending further experimentation with the object of perfecting this type for extensive use in museums.

A PERMANENT TAG FOR MUSEUM SPECIMENS

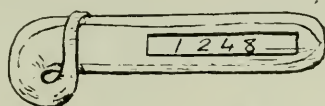
J. FRANK PAYNE

University of Toronto

Previous to 1922 our method of tagging museum specimens, *i.e.*, tags of Bristol Board boiled in paraffin did not always prove satisfactory. In cases where the specimen was put immediately through the preserving fluids and then permanently mounted, we had no trouble. But when the specimen was shown a number of times in class, handled by many students, and then placed indefinitely in storage jars, we found these tags were not always reliable. This necessitated the designing of a tag which could be readily attached to the specimen, would withstand the action of any preserving fluid, permit of a fair amount of rough handling, and last indefinitely in a storage jar.

A tag possessing all these requirements can be made in the following manner. A piece of thick-walled glass tubing 5 m.m. in diameter held in the left hand is heated with a blow-pipe until soft enough to draw out and form a loop. This can be done by

touching it with a short piece of glass rod held in the right hand. The loop formed should be just large enough to pass a needle through, and it can be kept open by passing a darning needle part-way through before it cools. Cut off in lengths of $2\frac{1}{2}$ cm. On a strip of white paper 1 cm. wide write in a column, with a mapping pen and black India ink, the series of numbers required (on both sides of the paper). They should be written small enough so



GLASS TAG FOR SPECIMENS.

that when clipped off they will drop easily into the glass tubes. The open end is then sealed with the blow pipe. Hold the tube, open end up, with a pair of forceps, care being taken that the enclosed number is shaken down to the loop end of the tube or it will burn before the process of sealing is complete. When cool for convenience, the tags may be threaded numerically on a piece of string.

TYPEWRITING LABELS ON MUSEUM JARS*

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*From the Department of Pathology, Army Medical Museum,
Washington*

An ideal method for labelling museum specimens has not been devised. The museum label is, as a rule, unsightly and out of harmony with the specimen. The story suggested by the label and that told by the specimen itself should harmonize and run hand-in-hand, so that one hardly notices where one ends and the other begins. At the same time the printed label must be stimulating and written in such a manner that the student will not only read the label but will read it in connection with the specimen.

This simple method of labelling jars possesses a few of the ideal qualities for a museum label. It is artistic. It is simple and easy to put on. After it is thoroughly dry the face of the jar can be washed with soap and water without washing off or injuring the

*Presented at the 12th Annual Meeting of the American and Canadian Section of this Association, Atlantic City, N.J., June 14th, 1919.

label. If necessary, almost the entire front of the jar may be written over and the specimen can still be seen and studied.

The process itself is a very old one. It consists simply in cutting a wax stencil with the A.B. Dick silk sheet mimeograph process and transferring the letters to the jar by pressing paint of the desired colour through the stencil on to the face of the jar. The trade name of the stencil is "Composite Mimeograph Stencil No. 760". It can be purchased at almost any stationery store.

A little practice will be necessary in order to get a clear cut letter. The first essential is a clear cut stencil. If the letters are not well cut naturally the ink will not go through. A special labelling Hammond typewriter has been used to advantage, any machine however, will answer, provided the stencil is cut with an even stroke. Each label must be cut out from the wax sheet, leaving enough margin to be sure that the paint does not lap over the edges. Best quality tube printers inks have been found to answer every purpose. These come in all colours and dry hard so that the face of the jar may be washed without injuring the letters. Artists oil colours are also very good provided they are not too moist. To make a clear cut even letter the paint should be about the consistency of soft table butter. If oil colours are used the excess oil may be absorbed by squeezing sufficient paint out on a piece of blotting paper. After the label is cut out it is placed on blotting paper and a thin, even layer of the printers ink is spread over the letters with the ball of the thumb or hand. Or better still, a small hole is punched in the cap of the tube containing the ink and a line of the paint is squeezed out on each row of letters. The stencil is then placed in position on the specimen or jar to be labelled. One edge is held down with the left thumb and the ink is pressed through the stencil by exerting an even, smooth pressure with the ball of the right thumb or hand. The stencil is then peeled off and discarded. The letters having been pressed through the stencil onto the face of the jar.

A soft artist's brush may also be used on the stencil. The brush should have the bristles cut off short with the scissors. The stencil is held in position and the brush is run down each line of letters with a good quantity of ink adhering to the bristles, using sufficient pressure to insure squeezing the ink through.

Ink must not be pressed through the stencil before it is placed in position on the jar. If this is done the letters will blur where the little particles of ink strike the jar in shifting the stencil to its correct position.

The process may be used to advantage for general descriptive labels as well as for labelling the jars and objects themselves. For

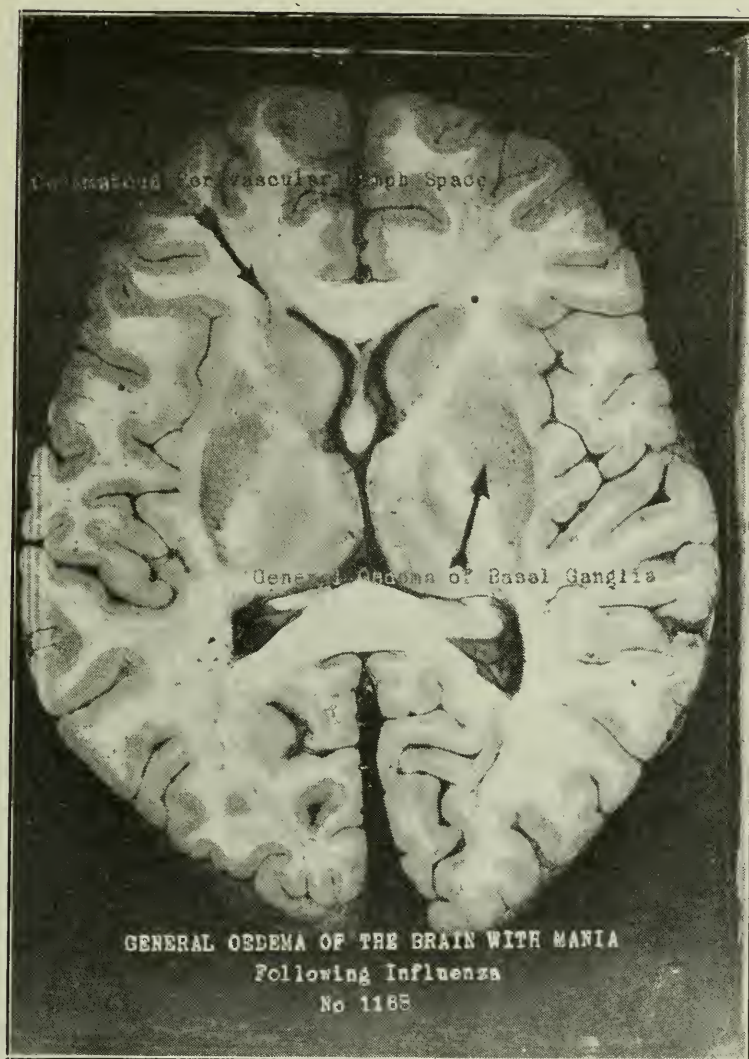


FIG. I.

Typewriting Labels on Museum Jars.

this purpose the lettering is transferred direct to the glass front of the case, or a cardboard shield may be cut out to fit the jars and the general labels stenciled on the cardboard. Local labels, pointing out small points or lesions of importance, should be stenciled on the face of the jar, with an arrow or asterisk indicating the point in question.—See Fig. 1.

MUSEUM ARRANGEMENT

THE SOUCHON MUSEUM OF NORMAL ANATOMY AT TULANE UNIVERSITY, NEW ORLEANS, LA.

EDMOND SOUCHON, M.D.

This museum occupies, in the New Richardson Memorial on Tulane Campus, a large room, 85 x 36 feet, flooded with light through numerous windows and skylights.

A notable and unique feature, it contains no cases against the walls or otherwise, but only rows of tables on which the preparations stand in large glass jars (36 inches by $7\frac{1}{2}$, 24 by $11\frac{1}{2}$, 24 by $7\frac{1}{2}$), so that the students can come right on them and study them.

There are in the museum no papier mache, no wax models, no dried specimens.

It is composed exclusively of the "real things" of dissections made after the new methods elaborated by the writer, with the liberal financial aid and the encouragement of Tulane.

It is essentially a modern study museum in the fullest meaning of the words.

The museum possesses sixty-seven large glass jars with preparations on osteology, forming a complete collection unequalled in any other medical school except Harvard.

Next come four hundred glass jars containing actual dissections, with permanent colour of muscles, vessels, nerves and organs. No such preparations with permanent colour exist in any other college in the United States, or in Europe, so far as we could ascertain in our travels.

Each structure in each specimen bears a number, and on an appended card is the name of the structure opposite the number.

The great advantages of this modern study museum are to prepare the students for the dissecting room; to assist them during their dissections, when they are embarrassed; to show them the great number of things which they do not and cannot dissect in an ordinary dissecting room course. It enables them to review rapidly and it affords old students and graduates the opportunity to rapidly "relearn" much anatomy. The preparations can be taken into the dissecting room and guide the students in their dissecting.

At the New Orleans Meeting of the American Medical Association in April, 1920, the Committee awarded the Gold Medal to the anatomic dissections from the Souchon museum.

The Souchon methods for the preservation of anatomic dissections with permanent colours were published in the *Anatomical Record*, Nov., 1915, March, 1917, Dec., 1921.

PHOTOGRAPHY

THE PHOTOGRAPHY OF GROSS PATHOLOGICAL MATERIAL*

THEODORE BITTERMAN

Captain, Med. Adm. Corps, U.S. Army

The following is a description of the apparatus which has been in use at the Army Medical Museum during the past two years in the photography of gross specimens. It was devised with the idea of perfecting the very unsatisfactory existing technique of this class of photography. Much help was obtained from the previous work of L. B. Wilson and Andrews at the Mayo Foundation, Rochester, Minnesota, and acknowledgment is here made of many helpful suggestions received personally from Dr. Wilson.

Box.—It has long been recognized that the most satisfactory method of eliminating high lights, and still preserving the minute details of tissue structure, can best be had by immersing the specimen in water. To this end we have had constructed a box (Plate 2) consisting of an iron casting with four plate glass sides and a plate glass bottom firmly held in place by asphalt cement. This box rests on four iron legs 10 inches above the floor. Its dimensions are,—height $6\frac{1}{2}$ inches, width 16 inches and length 25 inches. Near one corner of the bottom plate a hole 1 inch in diameter has been bored to facilitate emptying. While in use this is closed with a rubber stopper. The box has been found to serve its purposes admirably. The frame is rigid yet not too heavy. No shadows are cast on the specimen since its walls are transparent. The size has been found ample to accomodate practically any ordinary pathological specimen. The height from the floor is necessary to diffuse the shadows cast by the specimen. If, however, shadows still persist they are removed by illuminating the floor under the box by extra electric lights attached to the floor portables hereafter described. Either a white or black back-

*From the Laboratories of the Army Medical Museum, Washington D.C.

ground may be placed under the box as is required by the colour of the object to be photographed.

Illuminants.—The lighting of the specimen is obtained by means of four 100 W. type "C" (nitrogen filled) Mazda lamps, one of which is placed at each of the corners. It is probable that other illuminations would give equally satisfactory results so far as the quality of the light or volume is concerned, but we prefer the four lights placed in this manner because of the uniformity of its illumination when the specimen presents its lesions in only one plane, as in sections of the lung, liver, spleen, etc., as well as the facility with which the lights may be varied in position and certain ones eliminated when it is desired to accentuate elevations, cavities, variations in contour, etc., with the object of producing an impression of "relief". The standard "floor portable" or ordinary floor lamp to which the lights are attached has been found to lend itself admirably to this use. The "universal" joint by which the rod is attached to the stand permits of motion in any plane and extra rods carrying as many lights as may be desired can be readily added to the stand.

Camera.—The camera selected for this work is the "Folmer and Schwing Commercial" 8 x 10. It was chosen because of its great rigidity and its specially long bellows extension. It has all of the requirements of any good camera, such as the swing-back, rising and falling front, etc. It has been equipped with a "reducing back" to take 5 x 7 photographs. This is a great convenience in the matter of economy of material since many of the specimens do not require the 8 x 10 film. A long bellows extension is essential to permit of the use of long focus lenses especially when it is desired to photograph the specimen as nearly life size as possible.

Little attention has been paid to the question of lenses. Any anastigmatic lens of sufficiently long focus will give satisfactory results. Since speed is not necessary in this kind of work, and great detail and depth of focus are absolutely essential, it is obvious that the most satisfactory results will be obtained by "stopping down" to an aperture at least equivalent to F. 16, and since practically all lenses give the same results when used at F. 16, or smaller, the question of lenses is of little importance. The further advantage of "stopping down" is that the necessity for extreme accuracy in focusing is obviated and, at the same time, sufficient depth of focus is assured. Our ordinary practice is to take all photographs at an aperture at least equivalent to F. 22 and when the height of the specimen requires it to "stop" to F. 32 or F. 45. To obtain a proper perspective the lens should be of sufficient focal length to properly cover the plate used. For

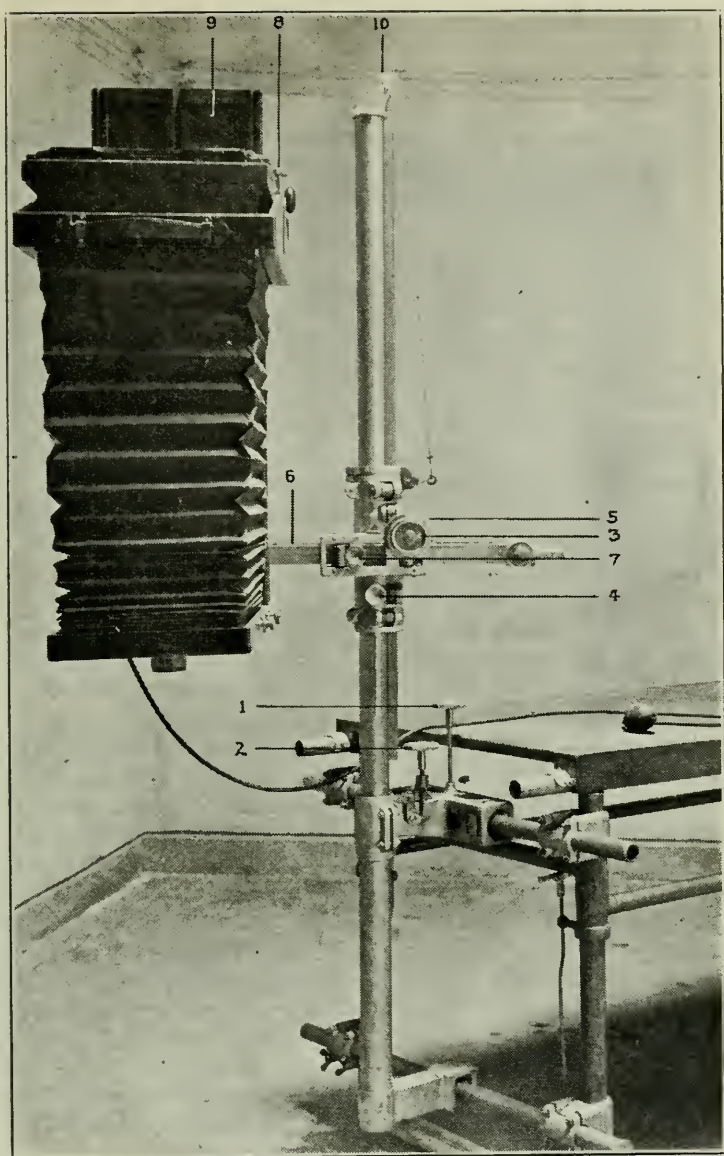


FIG. 1

Camera attached to hardwood board (9) which is fastened to horizontal bar (6) by heavy brass screws. Geared device (5) for motion in horizontal plane, controlled by a lock screw (7), handle (3) for vertical movement, locked by screw (4), steel cable over pole (10) for elevation of entire camera, band clutch (2) surrounding upright pillar permitting rotation of entire camera. Device (1) for moving camera in long axis of glass box. THEO. BITTERMAN.

5 x 7 views we use a lens of $8\frac{1}{2}$ inches focal length; for an 8 x 10 picture a lens of 13 inches focal length is used. The shutter with which this camera is equipped is the "Folmer and Schwing" studio shutter which has been found preferable to a "between-the-lens" shutter since it operates with no vibration and does not require setting. The camera being used only in a vertical position, it was found necessary to supplement the binding screw which makes it rigid on the camera bed, by means of an additional lock screw which is shown in Fig. 8 of Plate 1.

Camera Stand.—This consists of an X-ray table, the tube carrier of which has been utilized to carry the camera. This tube carrier was originally intended to run the length of the table. By means of a few mechanical alterations this carrying device has been transferred to the end of the table. The advantage of this apparatus, in spite of its apparent complexity, consists in the fact that after the specimen has been placed in water in the glass box it is no longer necessary to manipulate it in order to bring it to the centre of vision and the vibration of the specimen in water is thus prevented. The device enables us to move the camera in any possible direction desired, vertically, horizontally and from side to side, as well as the ability to swing the camera at any other angle. It also lends itself admirably to the taking of stereoscopic pictures should this be needed.

The camera, including its track, was attached to a hardwood board (Plate 1, Fig. 9) and this board was then fastened to the horizontal bar (Fig. 6) by means of three heavy brass screws set into a brass plate which has been counter-sunk near the lower portion of the board. Motion is obtained in a horizontal plane by turning the geared device (Fig. 5). This is controlled by a lock screw (Fig. 7). Movement in a vertical direction is obtained by turning the handle (Fig. 3) which is locked by a screw (Fig. 4). This movement, which elevates the entire camera is opposed by a counterweight sunk in the upright pillar and is carried by steel cable over the pulley (Fig. 10). A fourth movement (Fig. 2) which controls a band clutch surrounding the upright pillar, permits the rotation of the entire camera through an arc of 360 degrees. Fig. 1 in Plate 1 indicates the device which enables the camera to be moved in the long axis of the glass box.

The use of glass plates in this work has been almost entirely discontinued at this museum; in fact, except for an occasional "panchromatic" plate, they are never used. The "commercial orthonon" film as supplied by the Eastman Kodak Company has proven so eminently satisfactory that it would be unpleasant to contemplate the return to the use of glass plates. So far as can

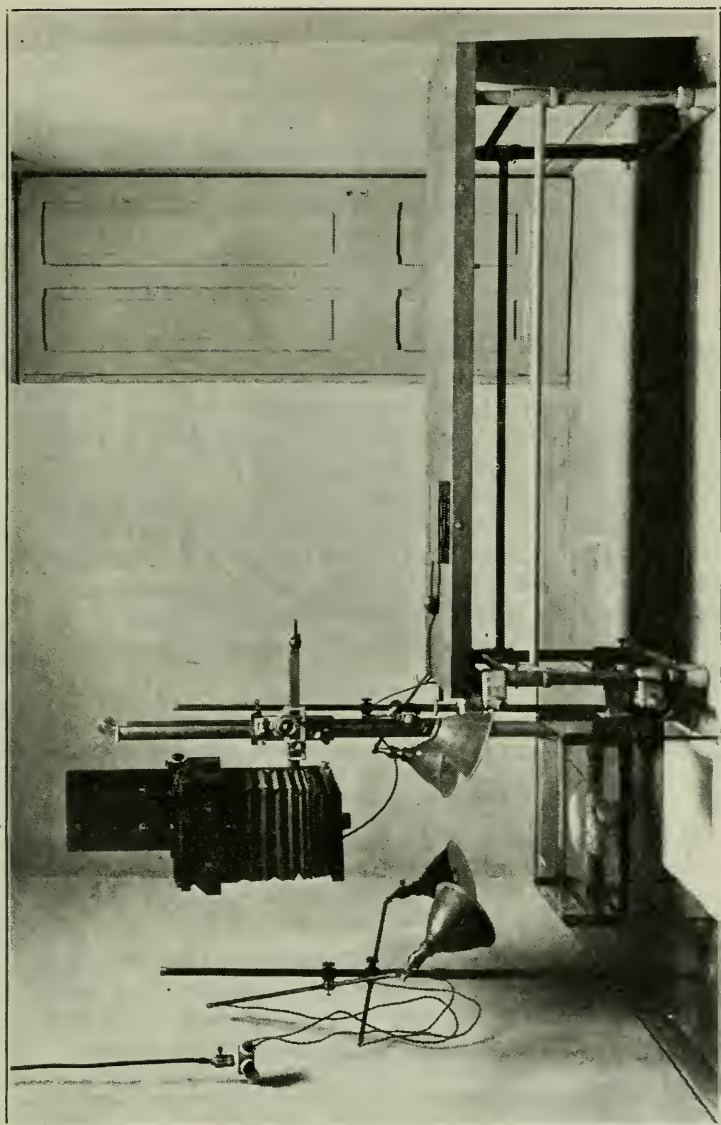


FIG. II.

Camera in position attached to tube-carrier of X-Ray table above iron casting of plate glass box 10" from floor.
THEO. BITTERMAN

be determined by the most critical examination the film gives a result in every way as satisfactory as the plate and has the further very great advantage of being light, easily filled with the impossibility of breakage and loss of valuable records and very considerably less space used in storage. It is possible to develop twenty-four films at one time in the tank with greater ease and comfort than the handling of a single plate. Except for an occasional specimen where reds must be differentiated from browns and blacks the "commercial orthonon" film has sufficient colour gradation to satisfy ordinary needs. In the other cases, however, recourse must be had to the panchromatic plate and filter. In such cases we find the Wratten and Wainwright K3 filter satisfactory for all ordinary conditions. The use of four lights as described above, the "commercial orthonon" film, and with the lens "stopped" to F. 22, the average exposure is from 1 to 3 minutes, depending upon the colour of the specimen. The panchromatic plate with the K3 filter requires about the same exposure as the commercial orthonon film with no filter. Although it is recognized that a stereoscopic picture is superior to one taken with a single lens, we have paid little attention to this branch of photography. The objection to stereoscopic photography is that it does not lend itself to publication and requires the use of a stereoscope to properly view its results. Since the work at this museum is primarily done with a view to incorporating the pictures in the museum catalogue, it was not found practicable to consider stereoscopic pictures.

STEREO-PHOTOGRAPHY AND STEREO-PROJECTION*

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INTRODUCTION

It is not intended here to indulge in a historical review of the subject under discussion. Many have given thought to the problem and justice could not be done to the multitude of workers along these lines without extending the article to undue length.

*This article replaces three communications upon the technique and demonstration of Stereoscopic Photography and its Application to Embryology and Anatomy for Purposes of Record and Teaching, made by Professors T. Wingate Todd, N. W. Ingalls, and Miss Helen F. Harvey. Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

It is desired simply to put upon record the results of our own investigation which have the merit of practicability for teaching purposes and involve neither elaborate equipment nor unjustifiable expenditure of time.

CAMERA AND PHOTOGRAPHIC TECHNIQUE

The camera used by the anatomical laboratory for stereoscopic photography is the Photomicrographic Camera, Model H of Bausch and Lomb, modified to meet the special requirements of this work (Fig. 1.). The camera box is clamped to a freely movable supporting arm which is pivoted at one end and thus forms a radius of a circle whose centre is the axis of rotation. Thus the lens in any position of the camera always points to the centre of rotation, *i. e.*, the optical axis of the camera is a radius of the circle just described. The centre of rotation is sufficiently high above the base of the camera to provide space for a standard on which the object to be photographed is mounted. This allows for objects of varying depth as well as easy adjustment. Attached to the upper end of the supporting arm is a pointer which, as the camera swings, follows a graduated arc indicated on the wall just behind the instrument. By this means, the vertical position and the amount of inclination to either side may be readily determined.

The object to be stereoscopically photographed is set upon a standard which will easily permit vertical adjustment. An ordinary dissecting microscope-stand with the lens removed has been found by us to be convenient for most small objects. The object is adjusted approximately at the centre of rotation and brought into focus. Points of the specimen which are exactly in the centre of rotation will not change their position on the ground glass when the camera is inclined in either direction. Points above or below that centre will change their position. Consequently, a point about midway between the upper and lower surfaces of the specimen, or the region of special interest, regardless of its spatial relation to the whole, is chosen when adjusting the exact position of the specimen to the centre of rotation. After making finer adjustments of the specimen, the camera is swung first to one side of the vertical and then to the other for a final test. During this process, the same point will remain stationary on the ground glass, or it may change its position slightly. But, since only a very small linear portion of any object can possibly lie in the axis, a more exact adjustment is unnecessary. And, it follows that the deeper the specimen, the less serious is this slight change of position.

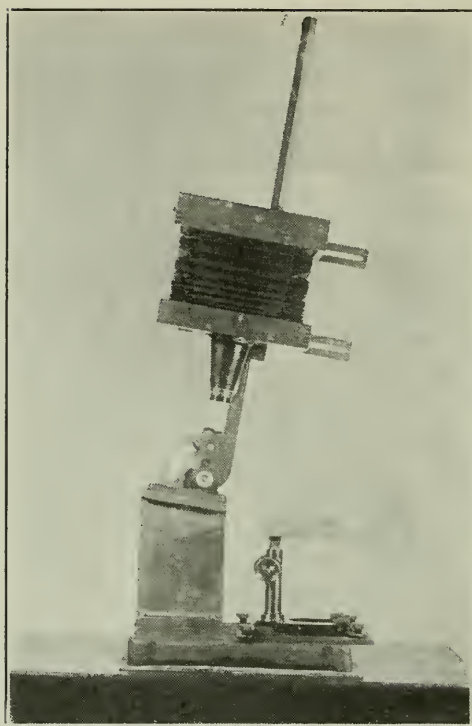


FIG. I.

Photomicrographic camera (B. & L. type H.) as modified for use as a stereoscopic camera.

Before the exposures are made, certain problems must be considered. In the first place, one must be very careful lest, in properly illuminating the object, the light shine on the lens when the camera is tilted away from the vertical position. A 500 watt "daylight" Mazda, usually with less intense counter-illumination, is used mainly in our work. When the light is quite close to the object for more brilliant illumination or when a flaring reflector is used this danger of light shining on the lens is a real one. And, under such conditions, a part or all of the negative will be clouded.

The angle of inclination of the camera so far in our work has averaged between 4° and 6° on each side of the vertical or a total difference of between 8° and 12° (angle of divergence) in the two positions of the camera. If there is considerable depth to the

specimen, the angle is reduced to a total of 6° , 4° or even 2° in extreme cases. Also, as the distance between the lens and the object increases, the angle would naturally be reduced. When the angle chosen is too great, there results an exaggeration in the depth and a consequent distorted effect. Hence, the question of the proper angle to be used varies with the specimen. Further consideration in regard to angles will appear later in this paper.

Two exposures are made on $3\frac{1}{4} \times 4\frac{1}{4}$ Orthonon plates with the camera adjusted to give a total angle of divergence of 4° - 6° . Later, the negatives are marked R and L to distinguish them. Occasionally, the desired view of an object can be obtained only by tilting the camera away from the vertical position. This is often the simplest way to obtain exact dorsal and ventral views of small embryos or other objects difficult to adjust. This new position of the camera may be taken as the starting point and exposures made at appropriate number of degrees on each side. In developing the plates considerable care must be used in judging their density so that the two will be as nearly uniform as possible. The same care must be taken in making the prints from the negatives. Since the exposures are made separately, there may unavoidably be a slight variance in the time of exposure with consequent differences in density or quality of the negatives. Such differences, if they occur at all, may be minimized or overcome through proper treatment of the developing negatives and prints; or if not, the slight inequalities become lost when the two photographs are viewed in the stereoscope. The advantages of a stereoscopic camera which makes the two pictures of an object with a single exposure would seem to be more theoretical than they are practical. The time element would be the only real advantage and usually this would be negligible.

MOUNTING OF PRINTS

The finished prints from the two negatives are placed on a card in the same corresponding position in which the two photographs were taken, *i. e.*, the one taken with the camera tilted to the right on the right side of the card, the one taken with the camera tilted to the left on the left side. Even with rough adjustment, the two photographs appear as one when viewed through the hand stereoscope, and the depth of the specimen shown as in the original. If the object has been photographed so that the image is right side up on the ground glass (and hence on the negatives and prints) no further arrangement of the prints is necessary. But, if for any reason as for purposes of better illumi-

No. 330 COLLECTIONS OF EMBRYOLOGY AND TERATOLOGY C.R. 31mm.

Normal HAMANN MUSEUM, DEPARTMENT OF ANATOMY, W. R. U. 9 weeks

Embryo, left lateral view, x 1. ♀

Note: General configuration of body and limbs, Shape of head, nose, mouth, eyes and eyelids, ear. Trunk with cord and ext. genitalia. Limbs, position, joints, position of feet. Phalangeal touch pads on fingers and toes.

Compare other views of same embryo.

Specimen from ruptured tubal pregnancy.



FIG. II.

Card taken from record to illustrate method of mounting stereoscopic photographs and explanatory note. Reduced. Actual size 7 x 9 in.

nation, the object is placed so that its image on the ground glass is wrong side up, the two prints must be reversed on the card, and this without changing their relation in position to each other. It follows that the photographs of an object with no absolutely necessary orientation may be viewed with equal satisfaction in either position. Should the exact orientation of the object when photographed be forgotten, one has only to experiment in order to obtain the true perspective and at the same time the natural placement of the prints on the card. When put in the wrong relation to each other, the result is a reversal of the perspective. *i.e.*, the convex areas become flattened or even concave and *vice versa*.

Until finer adjustments of the prints in relation to each other have been made, there will probably be some strain on the eyes, due to inexact fusion of images. The position of the prints in the horizontal axis must first be adjusted. Then the vertical axes must receive equally careful attention so that corresponding points on the two photographs are on an exact level. When the proper adjustment is attained the two views will fuse easily and completely. To bring about this result, the right photograph is fixed in place on the card temporarily and the left one moved toward it (while still viewing them through the stereoscope) until the brain is conscious of one object only. There is considerable horizontal range within which the object will appear in its proper perspective. The vertical range is extremely limited for the eye is better able to correct a lateral error than a vertical one.

The final effect produced through the stereoscope is such that the original object is imitated, in all its dimensions, relative position of its parts and in its natural appearance. The prints are then mounted on the card permanently. For record the stereophotographs are best kept in this mounted form (Fig. 2), which appears here with the text and shows the way in which records are kept in this laboratory.

STEREO-PROJECTION

Stereo-projection is the newest and most direct application that has been made of this kind of photography. For lectures and demonstrations it has been successfully used during the past year in the anatomical laboratory. The same negatives furnish both prints and lantern slides. In cases where an unusually sharp and contrasty lantern slide is needed for more striking effects, one may intensify the original negative before making the lantern slide, or better still, photograph the prints on to Process plates and make the lantern slides from these. The lantern which is used

for our projection work is a Bausch and Lomb dissolving BB Balopticon with two 400 watt Mazdas. In front of the right lens is a green colour filter which, when used alone, produces a green field on the screen. In front of the left lens is a red colour filter, alone producing a red field. The two fields of complimentary colours superimpose forming a single white field. When the two stereo-lantern slides are placed in the lantern, the separate images appear overlapping in the white field. But, when seen through "viewing spectacles", the right lens of which is green, the left one red, each eye picks out its own image and without conscious effort a single image without colour effect but with perspective and relief is formed, as appears when viewing the prints through the hand stereoscope.

Further explanation of the proper handling of lantern slides for projection is necessary. The right slide is placed behind the right (green) lens of the lantern (only with the usual inversion necessary to throw the image right side up on the screen) and the left slide is placed behind the left (red) lens. Here again as with the prints, one has to consider the position in which the object was originally photographed and, if necessary, reverse the lantern slides without changing their relation to each other, in order to see the image in the desired position. The possibility of viewing satisfactorily the slides in either of the two positions holds here as with the prints for objects which have no absolutely necessary orientation. If there has been any confusion in labelling the lantern slides or if one does not have the information about their position when photographed, their correct placement in the lantern may be quickly determined by experiment. The play of the lantern slides in the slide-holder allows one to move them nearer together or farther apart, thus causing the images to overlap more or less completely, laterally. Although experiment shows that the superposition of images should be almost complete in order to obtain the proper perspective without strain to the eyes, individual cases may call for a superposition not so complete. If the play of the lantern slides is not sufficient to allow for their required placement, a piece must be cut off from the side of one or both lantern slides. The lateral range within which one may view the image equally well is somewhat liberal, though not so liberal as in the case of prints. Vertically, corresponding points on the two images must be exactly upon the same level as the eyes are extremely sensitive to an error in that direction and easily strained thereby.

The looseness of the lantern slide in the $3\frac{1}{4} \times 4\frac{1}{4}$ printing frame is sometimes the cause of corresponding points on the two lantern slides not being on the same level, and the consequent

failure to superimpose them vertically when projected. In such a case, one of the lantern slides must be cut in such a manner as to bring the objects to exactly the same level on the screen. The mats which are used in mounting the lantern slides have to be treated in the same way as the lantern slides themselves so that the two will appear as one on the screen. The preliminary work of trying the slides in the lantern, securing the proper overlap and mounting is the most exacting and a very important part of the process. Their usefulness and success on the screen demands that great care be taken with this part of the technique.

A word may be said in regard to the favourable density of the lantern slides. An ordinary lantern can take care of a slide considerably denser than can the stereoscopic projection lantern. The red and green filters diminish the intensity of light on the screen, the red one more than the green. As a consequence lantern slides of only average density give the best results. In some instances unusually dense and contrasty lantern slides have been mounted together in their proper relation and used as transparencies with the hand stereoscope. The effect is especially brilliant due to the strong light penetrating them and every detail shows in a very natural manner. Such an arrangement has considerable value in preserving a record of the specimen as nearly like the original as possible. For beautiful results and accuracy of detail alike, this form of stereo-photograph is superior to any other.

The problem of the proper angle to be used in stereoscopic work has already been touched upon. It must now be considered from a broader standpoint. It has been said that the angle must lessen with the increased depth of the specimen in order to preserve the true perspective of the original. One has in mind, however, not minute differences in the angle, but large differences. It is a question whether the total angle should be 4° or 8° . There is practically no difficulty in superimposing objects with the hand stereoscope, when any reasonable angle has been used in their photography. The question is merely one of how much the exaggeration in one direction or another will affect the value of the result as a study.

For projection purposes the matter of the angle to be used is more important than for the hand stereoscope as the images will not superimpose without considerable eye strain, unless the proper angle is chosen. So, it is possible that the negatives which are made at a rather hastily chosen angle will not furnish both prints and lantern slides equally satisfactorily. However, since the angle suitable for the hand stereoscope is such a flexible one,

a little forethought in this regard in making the negatives will obviate the inconvenience in every case. Only experience can decide the precise angle of divergence at which any given object should be photographed, but speaking generally, an object which is so small that it has to be looked at very closely (or equally an object under magnification) requires a greater angle of divergence than a larger object which is being photographed at a reduction. For a bone surface like the pelvis of a rabbit a total angle of divergence of 4° is very satisfactory. For bringing into conspicuous relief areas of especial importance, a wide angle is sometimes intentionally chosen to exaggerate points of the specimen in consideration. Such treatment often has great value in class demonstration.

In conclusion, I would like to express my indebtedness both to Dr. Todd and Dr. Ingalls for much help in working out the technique which I have described.

THE ESSENTIALS OF PHOTOMICROGRAPHY*

F. B. MALLORY AND LILLIAN M. LEAVITT

(From the Pathological Laboratory of the Boston City Hospital)

There is little that is new or original in the directions and suggestions which follow. With one exception the formulæ have been common property at the Harvard Medical School and the Boston City Hospital for many years and can be strongly recommended.

While it is well to have a general idea of the wave theory of light involved in photographing stained sections, it is by no means necessary. On the other hand it is important to appreciate from the beginning the fact that a photomicrograph is never better than the field in the slide of which a picture is desired and it is usually poorer because a photograph can render neither colour nor depth of focus.

The first and greatest secret of good photomicrographs is perfect sections perfectly stained. If one has them the rest of the process is comparatively simple. The following example will serve to show how proper staining can help. It was recently desired to photograph sections of the liver from a case of hemochromatosis. The eosin-methylene blue stain showed a beautiful colour picture of blue nuclei, brownish granules of hemosiderin and

*Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

a pink background. Photographs of the sections were a blur; nothing stood out sharply defined. After considerable experimenting paraffin sections of Zenker-fixed tissue were stained deeply in alum hematoxylin and then placed in strong ammonium sulphide for five to eight minutes, washed thoroughly in water, dehydrated, cleared and mounted in xylol colophonium. The hemosiderin granules were black, the nuclei blue. Prints of negatives made from these slides were like etchings; they showed the nuclei pale but distinct and the hemosiderin granules an intense black on a light background. The result was almost as satisfactory as a colour picture and much simpler to make.

The second important point in photomicrography is choice of field. This is a time consuming process but it is absolutely necessary if the picture is to tell its story. No artefacts of any sort, such as scratches or foreign bodies, should be tolerated. The selected fields should be circled either by means of a diamond marker or with a pen dipped in methyl violet shellac. When it comes to photographing the desired fields they should be rotated by means of the movable stage until they present a well balanced appearance with the main lines running horizontally or vertically and with the most important feature in the centre of the field.

In photographing a series of slides it is advisable to do at one time all the fields requiring the same magnification. By this method the timing of the exposures is simplified and rendered a certainty and the changes of lenses, eye pieces and condensers reduced to a minimum. It will be found that as a rule it is much easier to take good high power pictures than those of low magnification.

The following staining methods all give good results photographically. An intense, sharp stain is desired but it should not be too deep except when very low magnification is wanted.

(a) Eosin and methylene blue after Zenker fixation; the best general stain and the one most commonly useful. Under this heading should be included the Giemsa and Romanowsky stains.

(b) Alum hematoxylin and eosin; used chiefly for celloidin sections. The resulting prints and lantern slides have a soft attractive quality. The hematoxylin alone is useful for bringing out the nuclei in Gram-Weigert and tubercle bacillus stains.

(c) Phosphotungstic acid hematoxylin; excellent for tumours, especially when mitotic figures and neuroglia, fibroglia or myoglia fibrils are present.

(d) Weigert's and Verhoeff's elastic tissue stains; the latter is especially designed for tissues fixed in Zenker's fluid.

(e) Gram-Weigert and tubercle bacillus staining methods.

Photomicrographic apparatus.—We are acquainted only with the Zeiss outfit which includes apochromatic lenses and compensating oculars. It can be highly recommended. Several other makes are on the market. Whatever one is available must be thoroughly studied and understood if it is to be used to the best advantage. The points to which especial attention must be paid are the leveling and alignment of the apparatus; the adjustment and centering of the arc light; the system of condensers used and their position relative to each other and to the microscope in order to produce the best lighting effect; the Abbe and simple substage condensers; the microscope and its lenses. If these are not all properly adjusted the pictures often show a peculiar blurring effect (halation?) which is displeasing.

It has been our experience and that of three or four others using similar outfits that better low power pictures can be obtained with a selected Leitz No. 3 achromatic objective and No. 1 eye piece than with the Zeiss apochromatic No. 16 objective and No. 4 compensating ocular. All the other Zeiss apochromatic objectives give excellent results as do also their planar lenses for very low powers.

Colour screen.—We have never used but one (to the despair of visiting salesmen with elaborate sets of colour screens to sell) and it works perfectly well with all the staining methods mentioned above. It is the following:

Copper sulphate	175. grams
Potassium bichromate	17. grams
Sulphuric acid	2. cc.
Water up to.....	500. cc.

It is used in a flat glass cell which is vaselined within along its upper edge and then sealed with surgical plaster to prevent evaporation.

Plates.—Cramer Isochromatic Slow. They were selected after much experimentation and have always given good results.

Developer for plates:

SOL. A	
Water	1000. cc.
Pyrogallie acid	20. grams
Potassium metabisulphite	2.5 grams

SOL. B	
Water	1000. cc.
Sodium sulphite (anhydrous)	100. grams
Sodium carbonate (anhydrous)	40. grams

Use equal parts for developing plates. Add ten to twelve

drops of a 10% aqueous solution of potassium bromide to 120 cc. of mixture.

This is a strongly alkaline pyrogallie mixture. A properly exposed plate is fully developed by it in three minutes. As soon as the developer is poured over the plate brush the surface gently with a wad of cotton to remove all air bubbles. Go over the surface in the same way after the plate is washed and just before it is put to dry in order to remove any particles of dirt or iron rust in the running water which may have been deposited on it. It is desirable always to err on the side of underexposure as this fault is more quickly appreciated and corrected than overexposure.

Fixative for plates and prints:

A		
Water	3840. cc.	
Sodium hyposulphite	960. grams	
B		
Water	960. cc.	
Sodium sulphite (anhydrous)	90. grams	
Sulphuric acid	15. cc.	
Chrome alum (powdered)	60. grams	

Pour B into A while stirring well. Fix about twenty minutes.

This is the acid chrome alum fixing solution in general use by professional photographers. It keeps indefinitely in stock solution.

Printing paper.—Normal Glossy Cyko. We have found this paper very satisfactory for our negatives but other glossy papers on the market may give as good or possibly even better results. Only trial will tell.

Developer for prints:

Metol	1. gram
Hydrochinon	3.5 grams
Sodium sulphite (anhydrous)	24. grams
Sodium carbonate (anhydrous)	24. grams
Potassium bromide	1.3 grams
Water	1000. cc.

As is well known the metol sometimes causes eczema on the fingers but with a little care or by the use of rubber cots this can usually be avoided.

Squeegeeing.—After the prints have been fixed and washed they are squeegeed on to the surface of ferrotype plates.

To prevent sticking, a few drops of a *saturated solution of white beeswax in turpentine or in xylol* are poured on the plate and then the surface is rubbed with a soft towel until it is highly polished.

As prints prepared in this way often show a moth eaten appearance on the surface where particles of air have prevented intimate contact with the plate we have found it advisable to dip the prints *in 25% alcohol* just before squeegeeing them.

Old prints can be treated in the same way if they are first soaked in water. As soon as the prints come off the plates they should be put under pressure (between the leaves of a book will do) to prevent curling. If they have curled at all badly hold them over a steaming dish of hot water for a moment to soften the surface and then run the prints over the edges of a desk or table, with the print surface uppermost to reverse the curl and then put under pressure again until perfectly dry.

Lantern slides.—We have used various makes and have found most of them satisfactory.

Developer for lantern slides:

Water	1000. cc.
Hydrochinon	6.25 grams
Sodium sulphite	11.25 grams
Citric acid	0.7 grams
Potassium bromide	0.7 grams
Sodium carbonate (anhydrous).	50. grams

Dissolve in order listed. Develops slowly at first, rapidly later.

Do not overexpose; develop up full; make exposures in an enlarging and reducing camera, not by direct contact.

A working knowledge of photography is a desirable asset before undertaking photomicrography, but with persistence and experience anyone can in time expect to get fairly good results.

MICROSCOPIC TECHNIQUE

Retrospect: THE PRESENT STATUS OF THE HISTOLOGIC TECHNIQUE USED IN PATHOLOGY*

F. B. MALLORY, M.D.

(From the Pathological Laboratory of the Boston City Hospital.)

The fundamental principles of histologic technique as applied to pathology are well established. Revolutionary discoveries are not likely, but slight changes are constantly taking place. Some of them are good and others not. We are compelled to become what Weigert despised, Mr. Modifiers; but even he appreciated all steps in advance, and occasionally some one makes a distinct improvement along one line or another. The important thing is to recognize and select for use the best methods, understand them thoroughly and apply them effectively. One can do a great deal if his tools, even if few in number, are of the best and he knows how to use them with a high degree of intelligence.

Judging from sections and smears received from different parts of the country for examination it would seem that the poorer a pathologist is in technical skill and in knowledge of his line of work the less chance he gives himself for making a correct diagnosis and the more he is forced to guess—and to make others from whom he seeks aid to guess also. Formaldehyde fixation and frozen sections form the sole working outfit in too many laboratories. The better trained men on the other hand try to make their diagnostic problems as simple and easy for themselves as possible by employing the best available technical methods so as to be able to put positiveness in place of doubt. Without question 75 to 90%, perhaps more, of all diagnoses can be correctly made on tissues fixed in almost any way: but the remaining small percentage requires the best of fixation and staining to render possible an exact diagnosis. Personally I am a great believer in good technical methods as a foundation for pathological work. On this account I have been persuaded to discuss briefly the present status of the histological methods ordinarily used in a pathological laboratory and to call attention to a few recently published procedures which seem promising.

The staining of tissues embraces a series of steps of which the actual staining is usually not the most important. The vital point

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to bear in mind all the time is that all good histological work is based on two things, on obtaining tissues as fresh as possible and on fixing them properly. By fresh tissues I mean preferably those removed at surgical operations and preserved at once. Every minute's delay means deterioration. On this account post mortem material is much less valuable, but anything under three hours may be regarded as fairly good. In experimental work it is always advisable to kill the animals (and usually to bleed them at once) instead of waiting for them to die.

The tissues to be preserved should be cut in thin slices, 1 to 4 mm. thick. The reason for this is that all fixatives penetrate slowly and the cells away from the surface undergo retrograde changes, before the fixative reaches them, as readily as they would in the body. Organs like the liver and spleen must be cut especially thin because the presence of much blood in them prevents the penetration of the fixing reagents.

Fixatives: The best fixatives are combinations of reagents having different properties. No one of them is perfect. The one which without much question stands at the head of the list as the best fixative for general purposes is Zenker's fluid, but it has certain drawbacks. For one thing the acetic acid penetrates more rapidly than the other ingredients and dissolves the hæmoglobin out of the red blood corpuscles below a certain depth from the surface. When it is desired to preserve certain cytoplasmic granules, as for example in the islet cells of the pancreas, the acetic acid must be omitted or replaced by formaldehyde, but the resulting mixture is not so good.

The common fixative in the old days for ordinary routine work was alcohol; nowadays it is formaldehyde. They both have their uses and with each of them fair work may be done; but the tendency of too many men is to depend on formaldehyde almost exclusively for all their work.

For the ordinary routine diagnosis work on surgical specimens a mixture of ninety parts of 95% alcohol to ten parts of formalin can be highly recommended. It has some of the good properties of both reagents, fixing and dehydrating at the same time. In addition thin sections from all important, fresh or interesting specimens, especially tumours, should be preserved in Zenker's fluid so that differential stains can be done later if they should be found necessary. Other fixatives are used only when required for some definite purpose such as formaldehyde for fat, spirochetes or nerve tissue and alcohol for pigments, glycogen, biurate of sodium crystals.

Postmortem material should be preferably preserved in Zenker's fluid for histological study. It is advisable to put a small

amount in formaldehyde also in case fat or pigment stains should be required. Occasionally other fixatives are needed in addition.

Sections: There are three methods of obtaining sections of tissues, either after paraffin or celloidin embedding or after freezing. The paraffin method is always to be preferred when possible because it yields the thinnest sections, but it is best suited only to material fixed in solutions containing chrome salts, such as Zenker's fluid. After formaldehyde and alcohol fixation there is altogether too great shrinkage.

For routine surgical work the choice practically narrows down to celloidin sections after any fixative preferred, or to frozen sections after preservation in formaldehyde. The latter method appeals very strongly to many workers but personally I do not care for it except for certain definite purposes, as for example when it is desired to stain for fat. On the other hand I use frozen sections of fresh tissue a good deal when rush diagnoses are wanted.

Dyes: At the present time it is difficult to obtain reliable staining materials as the old supplies give out. No one firm is likely in this country to control all the business of testing and retailing the various dyes needed in the school and hospital laboratories, as Gruebler's did in Germany before the war. A movement is on foot, however, at the present time to improve the situation. The best plan seems to be for certain laboratory men to test out the products of the most reliable manufacturers and then to have the retailers dispense under the makers' names those products which have been found satisfactory.

Staining Methods: The first thing to realize when it comes to staining sections is that it is impossible to build up a good system of staining methods on the basis of fixation in formaldehyde. It is partly on this account and partly because of the much better preservation of tissue elements and of mitotic figures in Zenker's fluid that this solution has been so strongly recommended under fixatives.

The carmine stains are little used nowadays except for two purposes: to stain tissues in bulk and, by Best's most excellent method, to demonstrate glycogen.

Hematoxylin, on the other hand, still holds its own and is likely to continue to do so owing to its property of combining with a number of different metals to form coloured compounds which have various intense staining properties. Alum hematoxylin, either alone or with eosin for contrast, is a most useful nuclear stain for tissues which have been fixed, whether they are cut by the celloidin or freezing method, but it is never so attractive when used on paraffin sections. As for staining the myelin sheaths of nerves

nothing has been found so far (except osmic acid) to replace its compounds with chromium, copper and iron. Hematoxylin is also exceedingly useful in combination with tungsten for demonstrating neuroglia, fibroglia and myoglia fibrils. Another useful compound with iron appears in Verhoeff's stain for elastic fibers after Zenker's fixation.

Of the many aniline dyes in the market only a very few are used commonly in pathological laboratories. At the head of the list is methylene blue. For tissues it finds its greatest value as a nuclear and bacterial stain in contrast with eosin after Zenker fixation. No other staining combination approaches it in intensity, brilliancy and general usefulness. It is also used extensively in Loeffler's and other solutions for the staining of smear preparations of bacteria in general and of the diphtheria bacillus in particular.

Methylene blue has the property of undergoing chemical change and giving rise to methylene azur and methylene violet, slowly under ordinary conditions, but rapidly under the action of alkalis and heat (Unna's polychrome methylene blue). It also combines chemically, like methylene azur, with eosin (Giemsa's Azur II) to form a neutral stain (Giemsa's Azur II eosin). A successful Romanowski stain embodies these two principles although at first they were not fully understood. Now there are many published methods for making solutions combining these two principles and useful for various purposes.

Methyl (or gentian) violet is extensively employed, aside from its use to demonstrate amyloid, chiefly in one way, in the Gram stain and its modifications. Stirling's solution has proved itself most valuable, at least for staining smears, on account of its keeping qualities owing to the low percentage of anilin present. When the classical solution is desired it is best to keep Weigert's two permanent stock solutions on hand and combine them as needed.

For sections a preliminary contrast stain with lithium carmine is usually employed, but for Zenker fixed tissues it is necessary to use a light stain with alum hematoxylin followed by eosin in order to get a good contrast. Another method recently introduced is to stain first with Goodpasture's carbol-anilin fuchsin, followed by a Gram-Weigert, as suggested by MacCallum (*J. Am. Med. Assoc.*, 1919, LXXII, 193). By this method both the Gram-positive and the Gram-negative organisms are stained intensely.

For smear preparations stained by Gram the general contrast stain for many years was Bismark brown. Later this was replaced by pyronin. For the past three years this dye has not been

on the market, so dilute carbol-fuchsin has been used in many laboratories. This is a dangerous procedure because overstaining occurs so readily that the methyl violet is washed out making Gram-positive organisms appear Gram-negative. In one laboratory the carbol-fuchsin was allowed to stay on the smears for five minutes. As a result all the organisms were stained red. A dilute solution of safranin O, one-twentieth of one per cent., for twenty seconds, will be found very satisfactory.

Fuchsin serves two good purposes: to stain the tubercle and other acid-fast bacilli and to stain hemofuscin. The best contrast stain is furnished by alum hematoxylin for sections and methylene blue for smears.

Thionin used in a one per cent. solution in 20% alcohol will be found most satisfactory for staining frozen sections of fresh tissue when rush diagnoses are required. Stain the sections on the slide for one half to one and a half minutes, wash off in water and mount in water. The stain is metachromatic; nuclei blue to purple, collagen fibres pink.

Acid fuchsin is useful in combination with picric acid (van Gieson) for staining collagen fibrils after any fixative. Used in the aniline blue method for collagen after Zenker-fixation a much more intense differential colouring is obtained; nuclei and neuroglia, fibroglia and myoglia fibrils red; collagen fibrils blue. After other fixatives the results are not satisfactory. The great fault of the stain is that the red is not permanent.

The following methods may prove useful:

K. N. Atkins (*J. Bact.*, 1920, V, 321-324) recommends the following modifications of the Gram method.

Staining Solution:

Gentian violet, saturated solution in 95% alcohol	1
1% aqueous solution of aniline sulphate	3
The sulphate of aniline is stable either dry or dissolved in water.	
The gentian violet solution keeps indefinitely.	

Iodin Solution:

Iodin	2.gms
Normal solution of sodium hydrate (NaOH)	10.cc.
Water	90.cc.
Dissolve the iodine in the sodium hydrate, then add the water.	

Directions:

1. Stains smears, one minute.
2. Wash quickly in water.
3. Iodin solution one minute.
4. Wash in water.
5. Alcohol, dry, mount.

As soon as the iodine is poured on the preparation the aniline sulphate is decomposed and the conditions are then as in the classical Gram stain.

J. Beauverie (*Compt. rend. soc. de biol.*, Paris, 1917, LXXX, 609).

Method for staining the metachromatic granules of the diphtheria bacillus.

1. Fix in alcohol (not by heat).
2. Stain 2-3 minutes with aqueous or Loeffler's solution of methylene blue.
3. Wash in water.
4. Lugol's solution, 2-3 minutes.
5. Wash in water, dry and mount.

A counterstain with 1% eosin gives a fine double stain.

E. Kongsted (*Centralbl. f. Bakteriologie*, 1920, LXXXIV, 513-515) claims as the result of a comparative study that the Herman method of staining tubercle bacilli gives more reliable results than the Ziehl-Neelsen. Herman's method (*Annales de L'Inst. Pasteur*, 1908, p. 92) is as follows:

- | | |
|--|---|
| 3% solution of crystal violet in 95% alcohol . . . | 1 |
| 1% aqueous solution of ammonium carbonate | 3 |
- Always mix fresh for staining.

Directions:

1. Steam one minute.
2. Decolourize in 10% nitric acid one minute.
3. Wash in water.
4. 95% alcohol, dry, mount.

For contrast stain use 1% eosin.

A.—Ch. Hollande (*Compt. rend. soc. de biol.*, Paris, 1918, LXXXI, 223-225) recommends pure amylic alcohol in place of absolute ethyl alcohol for dehydration. It has two advantages besides a lower cost. It does not readily take up moisture from the air, and in embedding tissues they can be passed directly from it to liquid petroleum and then into paraffin. Experience has shown that tissues can stay indefinitely in liquid petroleum without injury.

In dehydrating sections he passes them through the following series:

- 95% alcohol.
amylic alcohol,
equal parts of amylic alcohol and xylol,
xylol and balsam.

TECHNIQUE OF THE PREPARATION OF SERIAL SECTIONS OF THE BRAIN FOR MICROSCOPICAL STUDY

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The purpose of this article is to give in general the various procedures involved in the preparation of the brain for microscopical study. The steps include all the processes from the removal of the brain from the body to the completed mounts and are given in consecutive order. The following enumeration gives a brief outline of the steps to be considered: removal of brain from body; fixation of brain; gross examination; determination of pathological condition and of method of staining to be followed; dehydration of tissue; embedding of tissue; blocking of tissue; mounting of block; sharpening of knife; cutting and numbering of sections; staining, dehydrating and mounting of sections.

REMOVAL OF BRAIN

In our institution the removal of the brain is done by the circular incision method as given in Cattell, *Post Mortem Pathology*, 1906, or Wadsworth, 1915. The physical diagnosis and the appearance of the brain determine whether or not the cord will be taken out. If it is to be removed, the method given in the authorities just named is followed.

FIXATION OF BRAIN

In all probability, formaldehyde is finding its greatest use as a fixative of the central nervous system. It penetrates and fixes with great rapidity. A whole brain will be so well fixed in two to three weeks that serial sections can be made through it without fear of the internal structures being improperly fixed or their general architecture altered. This preliminary fixation may be followed to good advantage by other fixing or hardening agents which not only enables the tissue to resist the shrinking effects of alcohol but also serves a second purpose of mordanting, this being especially true in the Weigert stain for myelin sheaths. To properly fix the brain it should be immersed, dorsal surface down, in a ten per cent. formalin solution, allowed to rest on a cotton pad, and turned every twenty-four hours for several days to pre-

vent flattening; or suspended in the solution from the cover by a string tied about the basilar vessels.

GROSS EXAMINATION

At the time of autopsy the brain is examined externally for general appearance, atrophy, lesions, indication of hæmorrhage, tumors and the like. If it is desired to ascertain the internal condition at this time the horizontal cut (See Fig. 1 and 2) should be made in preference to the transverse one. However, from the standpoint of a well shaped specimen after fixation, it is advisable to fix the brain before cutting. Blocks may be taken from the frontal, central, and occipital regions of the cerebrum, from the cerebellum and the cord for routine diagnosis. Photographs should be taken of the brain either in the fresh or fixed condition to show lesions on the surface. If the brain is to be sectioned serially, it is cut after fixation into blocks of the desired thickness and photographs taken of the cut surfaces. When cutting the brain into blocks, due regard should be taken of the lesions present to preserve them in their entirety as far as possible, as many sections on the surface of the block are lost in the leveling process when cutting. If cut carefully in the gross, a brain may be divided into two or three centimeter thick blocks or the entire brain may be cut into two or three blocks, as desired. Of course the latter method is preferable if there is an extensive lesion, for otherwise, many of the sections through the extent of the lesion would be lost in the cutting process.

DETERMINATION OF THE GENERAL PATHOLOGICAL CONDITION AND OF THE METHOD OF STAINING

The pathology of the brain and the elements to be stained determine the technique. Weigert or Weigert-Pal methods are generally used on these sections as a large part of the staining is for myelin sheaths. The latter can be followed by a carmine counter stain for cells. If the Weigert stain is to be used the tissue can be mordanted either in the block or in the section, while in the latter case only the block mordanting is satisfactory; six weeks to two months mordanting is sufficient with Müllers fluid or potassium bichromate and chromium fluoride. In the section mordanting two days with potassium bichromate and chromium fluoride, or bichromate alone gives very satisfactory stains. A general cell stain such as hæmatoxylin and eosin or a specific cell stain as neutral red can be used if desired instead of a fiber stain.

DEHYDRATION

Dehydration of large blocks of tissue should be gradual and should be complete for each percentage of alcohol. This process may be accomplished by the use of gradually increasing grades of alcohol from 50 per cent. to absolute or by the application of grades from 80 per cent. to absolute in changes of 5 per cent. The length of time for the bath of each percentage of alcohol depends on the thickness of the block and the percentage of the alcohol. Opinions on this length of time vary to a considerable extent. One method which works satisfactorily recommends one hour in each bath of alcohol for each millimeter in thickness of the tissue block. It is also generally advisable to add a few hours to make the dehydration a sure thing. The tissue may be transferred from the absolute alcohol directly into the 5 per cent. celloidin¹ for infiltration, but since alcohol and ether in equal parts are the solvent for celloidin, the latter will penetrate more effectively if the tissue has a bath of this mixture. This bath should be of the same length of time as that of the absolute alcohol.

IMBEDDING

Infiltration with celloidin being done slowly and in the cold does not shrink the tissue appreciably. The main portion of the infiltration should take place in the five per cent. solution, the ventricles becoming filled and all the internal structures well supported and held together. A 2 cm. block should remain in the 5 per cent. solution for one to two months; a 7 to 9 cm. block, four to five months. It is advisable to leave the blocks in the thin solution if not ready to cut rather than in the 10 per cent. solution or hardened in the block. The blocks should remain in the 10 per cent. solution for from three weeks to two or three months.

BLOCKING

Preparatory to blocking the tissue a box of stiff firm paper is made with mitered corners and sides sufficiently high to allow for a considerable layer of celloidin above the tissue. The box is rubbed on the inside with glycerine to prevent sticking of the celloidin to the paper. Sufficient 20 per cent. celloidin to cover the bottom of the box is poured in, the block of tissue rinsed in ether and put in place in the box and celloidin poured around it

¹ Celloidin is the general term used to indicate any of the gun cotton by-products which are manufactured in the United States, such as parlodion, histoloid, bioloidin, etc.

until it is well covered. The box is then placed in an ether atmosphere to remove the bubbles in the celloidin, which may require from a few hours to overnight. This procedure also allows the thick celloidin to very intimately surround the block although it does not actually penetrate it. When the bubbles are entirely gone and there is still a good layer of celloidin over the tissue the cover of the dish is removed slightly to allow the air to enter in order to harden the surface of the celloidin. Gradually the cover may be entirely removed and when the celloidin is hard enough

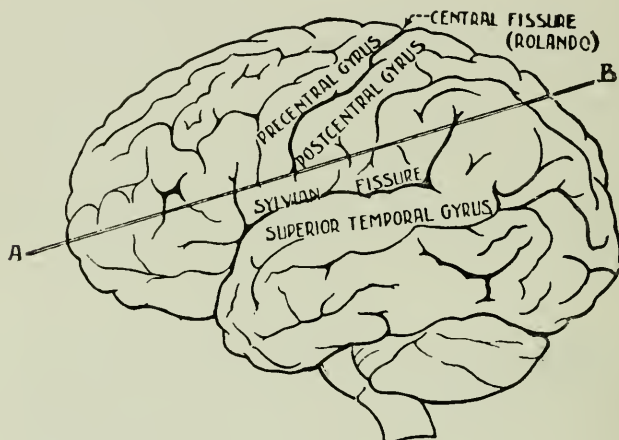


FIG. I.

Photograph showing line of cut at A-B for exposing interior of brain for postmortem examination. (Pathological Laboratory, St. Elizabeth's Hospital.)

so that it is not dented by the addition of alcohol, 80 per cent. alcohol is poured into the box and around it to continue the hardening of the celloidin toward the centre. Chloroform may be used instead of alcohol if desired. The result should be a hard, nearly transparent block in which the tissue is easily seen. As the block becomes firm the paper should be gradually torn away to allow for faster hardening on the interior. This hardening process often requires two to three or four days depending on the size of the block.

MOUNTING

When mounting these large blocks it is advisable to follow the same method each time in regard to the anterior and posterior surfaces. For instance, if the section is to be mounted on the

slide to conform to its location in the brain, then it is most convenient to cut from the anterior surface of the block which means that its posterior surface is placed next to the mounting block. If this arrangement is taken into consideration when the tissue is placed in the box in the thick celloidin, the anterior surface of the block may be placed on the bottom of the box and the layer of celloidin over the tissue will serve as a base for mounting the hardened block. The lower surface should be scored, the mounting block and the scored portion of the celloidin block well dehydrated with ether, the two cemented together with thick celloidin, and then placed in the same hardening solution as the celloidin block was in previously, that is: 80 per cent. alcohol or chloroform. The block will be firm and ready for cutting in about 24 hours.

SHARPENING OF THE KNIFE

A knife, well sharpened over the greater portion of the edge, is an essential factor when cutting large sections as there is very little opportunity for shifting it to change its position. This sharpening may be accomplished by the use of hones, a glass plate or strops. In every case a back or roll for the knife should be used and especial care should be taken to adjust it the same at all times.

When the knife for a large microtome, such as the Sartorius, is new it generally does not have a bevel and its edge is not plane so that there are many points on the edge which do not touch a level glass plate. This fact must be taken into consideration when sharpening. In such a condition, and if the knife is to be kept without a bevel (which is really preferable) it must be sharpened on strops. For this purpose three strops with different grades of abrasive mixtures are necessary for the quickest results and a good edge. Strops 12 by 55 cm. have proved satisfactory (See Fig. 3). Emery flour for the first one, two parts of rouge and one part of diamantine No. 1 for the second, in each case the powders thoroughly mixed and ground with neatsfoot oil, applied and rolled into the strops; and a plain oil dressing for the third, has provided three strops which have given good service. The emery strop removes the nicks and turned edges and grinds generally; the rouge and diamantine strop sharpens and the oil strop polishes. But continued stropping produces a round edge and when this occurs the knife must be put onto a hone or a glass plate to secure a sharp edge which in turn produces a bevel. In general the hones available are too small for sharpening a 45 cm. knife and in time the hone will cause the formation of a concave-shaped edge from end to end of the knife.

When the knife is sharpened on a glass plate it must be ground down so that at least the entire middle portion of the knife edge (that used in cutting) comes in contact with the plate on both sides. This is important, otherwise there will be an uneven sharpness of the edge with a resulting

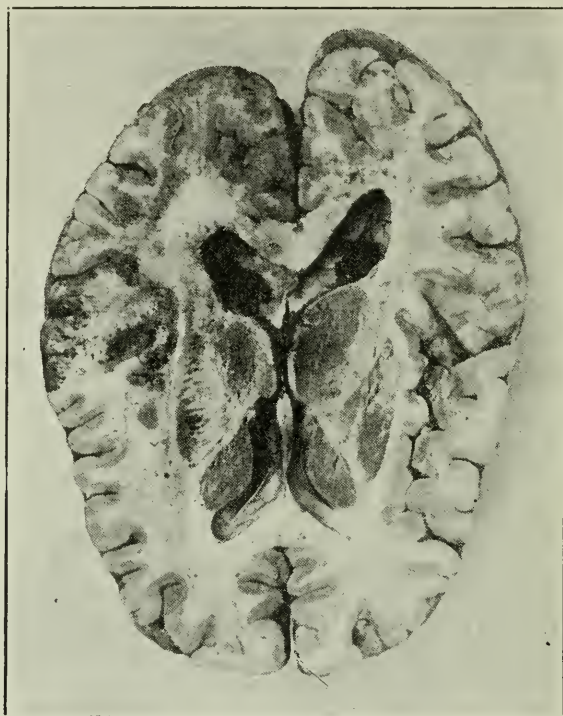


FIG. II.

Photograph showing cut section of brain after procedure in Fig. I., looking from above downward. (Pathological Laboratory, St. Elizabeth's Hospital.)

unevenness in the cutting of the sections. Emery for the grinding, diamantine No. 1 for the sharpening and diamantine No. 2 for the polishing are used on the glass plate. In all cases where emery is used it should be carefully prepared to remove any gritty particles. To do this mix the emery with a small amount of water to make a paste, dilute gradually, wash well and allow it to settle. Some preparations of emery will give a layer of the fine grade on the surface of the water and the coarser at the bot-

tom. Remove these two separately, wash again, filter, dry on filter paper and bottle for use. To prepare emery or diamantine for use on the glass plate, grind it into a smooth paste with a small amount of water, gradually adding more water until there is sufficient fluid to cover the central portion of the plate. Distilled water should be used and all dust removed from the plate before mixing the pastes. As is the case with any knife the bevel, if there is one, should be sharp and smooth as well as the edge. The type of edge may be watched under the microscope and the sharpness tested by any one of the various methods.

CUTTING AND NUMBERING OF THE SECTIONS

The Sartorius microtome is one of the large machines for cutting celloidin sections of brain or other blocks and is the one used at St. Elizabeth's Hospital. It is fitted with all of the necessary mechanical appliances, is supplied with a pan to be filled with alcohol in which the sections float off easily when cut and in addition has been equipped to operate by electricity.

When cutting any number of sections it is advisable that some method be found to keep them in serial order through the staining, dehydrating and mounting. The quickest and only sure method consists in numbering the section itself on the celloidin margin which surrounds the tissue, and not on the paper on which the section is carried. The Bates Numbering Machine, which works automatically and consecutively, accomplishes the work very effectively. The ink supplied with the machine is entirely satisfactory. The pressure administered when the numbers are applied stencils them into the celloidin and there is no danger of the digits being washed or rubbed off. Numbering may be done at the time of cutting and the sections to be stained removed from the series. To accomplish this, as the section is taken up on onion-skin paper, it is placed on a pad of blotting paper and the machine pressed down to make the number. One individual can handle the cutting and another, the numbering. If everything is working satisfactorily two persons can cut and number from 75 to 100 sections an hour. For the first general survey of such serial sections of a brain every tenth section may be removed from the first staining, the other sections being kept in serial order if any of them are desired later. For Weigert staining 60 microns is a desirable thickness for the sections while for cell stains, especially neutral red, they should not be over 50 microns.

STAINING, DEHYDRATING AND MOUNTING

These processes are carried out in accordance with the methods given in the various texts.

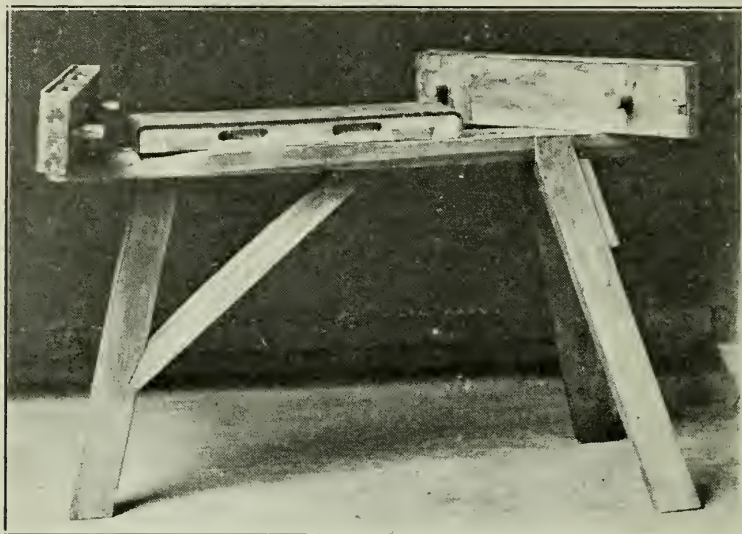


FIG. III.

Photograph showing strops and trestle for sharpening large microtome knives. (Pathological Laboratory, St. Elizabeth's Hospital.)

The technique involved in the preparation of neurological material as used by different investigators is essentially the same, although the methods employed may vary to a considerable extent. In this article I have endeavoured to lay stress on some of the processes accomplishing definitely known results.

MYELIN STAINS FOR ROUTINE WORK

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One of the difficulties which the beginner has to face in neuropathology is the choice of one out of the large number of modifications of the methods in common use for the demonstration of particular elements in nervous tissues. No claim for originality is made for either of the two given here. They have been used for a number of years in a large variety of nervous lesions and the results have been quite constant. Both methods can be strongly recommended for routine work.

PAL-KULTSCHITZKY METHOD FOR NORMAL MYELIN

Uniformly good results have been obtained in normal and pathological human material with the following modification of the Weigert-Pal myelin stain with which I have worked successfully for years.

The proposed modification is quite reliable and gives a good stain even of the finest medullated nerve-fibres. It is particularly suitable for routine work and offers the advantage of being applicable to material which has been kept in formalin even for several years without having recourse to subsequent long chromatisation. The minimum time for a good fixation of relatively small pieces in 10 per cent. formalin has been found to be about ten days. Large pieces, such as the medulla oblongata, pons, or whole brains, should be fixed in 10 or 15 per cent. formalin (prepared with tap water) for not less than twenty days in the case of the mid-brain and about two months for whole brains. The fixing solution should be changed from time to time.

For the actual execution of the modification, pieces or slices not thicker than $\frac{1}{2}$ -1 cm. are cut from the formalin material and directly put in Weigert's mordant: potassium bichromate, 2.5 gm.; fluorchroma, 12.5 gm.; distilled water, 500 cc. Here they are left for about eight days at room temperature. This should be prolonged to ten-twenty days for large slices of medulla, pons, cerebellum or cerebrum. I have little experience of mordanting very large slices of whole brains, but I would advise leaving them in the mordant for thirty days, the fluid being changed several times. It is not advisable to mordant tissues for periods

longer than the stated ones. Attempts were made to hasten the mordanting by using an incubator at 36°-37° C. but the results were not satisfactory as the tissues became brittle and the edges of the pieces somewhat altered by the excessive action of the mordant.

After mordanting, the pieces are washed in running tap water overnight and passed slowly through alcohols of ascending strength and embedded in celloidin in the usual way. Embedding in gelatin was attempted but without satisfactory results. Sections of 30 cc. or thicker, are cut and transferred to distilled water which is repeatedly changed. Should it become evident in cutting that the mordant has not penetrated sufficiently deeply into the tissue, the sections should be put back into the mordant for two-three days before staining. The washed sections are transferred to Kultschitzky's hæmatoxylin and there left for about twenty-four hours. A longer stay, though harmless, is of no particular advantage. The stained sections are washed in distilled water and then placed in another vessel of distilled water to which 1.-3.cc. of a saturated solution of lithium carbonate per about 200 cc. of water have been added. They are moved about in this bath and, if necessary, transferred into a fresh one until the celloidin surrounding the sections is almost colourless. This treatment is important because it uniformly removes the excess of stain and markedly shortens the time required for the differentiation. Moreover, it ensures a pure blue-black stain of the normal myelin, while no brownish patches are left in those parts which should be colourless.

After further rapid washing in distilled water, the sections are decolourised as usual by Pal's method, the stay in the solution of potassium permanganate varying from one to five minutes according to the thickness of the sections. After a thorough washing they are left overnight in a fresh quantity of distilled water to which a trace of lithium carbonate has been added. They are then ready for mounting in the usual way.

Should a counterstain be desired, alum-carminé is preferable for ordinary work, whilst eosin is the best for specimens which are to be photographed.

To distinguish the sides of pieces of spinal cord, medulla or pons, before the sections are cut, the following simple method has been found useful:

When the pieces are removed from the formalin, one of the two sides, *e. g.*, the right, is dried with a cloth and a black streak made with drawing ink. This is allowed to dry and the tissues are then put into the mordant. The black streak is easily recognised in the celloidin blocks which are pared differently on the two

sides, the uneven one being generally that on which the streak was made. The right and left sides of the cord or medulla are thus easily recognised in the sections. These, if belonging to different levels, *e.g.* of the cord, can be mounted on the same slide as follows: When the slide is on the stage of the microscope, the ventral surfaces are nearest to one, with the lowest level of the cord to the left and the highest to the right, whilst the left side of each level is also to one's left and the right is to one's right. This method of mounting greatly facilitates the study of the same tract at different levels.

MARCHI-BUSCH METHOD FOR RECENT DEGENERATION OF MYELIN

Tissues are fixed in just the same way as for the Pal-Kultschitzky method. Thin pieces $\frac{1}{4}$ cm. thick are cut and transferred without washing into Busch's fluid: (osmic acid, 1 part; sodium iodate, 3 parts; aq. dest. 300 parts). They are left here for one week, a little of the fresh solution being added every other day.

The pieces of tissue should be turned over every day to ensure uniform penetration. Again for large pieces, such as pons, etc., the staining should be continued for several days longer according to size. The pieces are next washed in running water and carried into celloidin as usual. Sections not more than 30 cc. thick are cut. It will be found that recently degenerated myelin, the lipochrome of ganglion cells and normal fat are stained black, the rest of the section being a dirty yellow in colour. The greater part of this yellowish stain should be removed by treating the sections by Pal's decolourising method (a stay of 5 minutes in the pot; permanganate solution is usually sufficient).

After thorough washing in distilled water, the sections are counterstained with alum-carmin and finally mounted in chloroform-balsam and never in xylol-balsam.

During my five years' experience of this method I have found that it possesses the following advantages over Marchi's original method:

- (1) The length of time is shortened from three weeks to one,
- (2) The cost of the reagent is less,
- (3) The tissues do not become brittle,
- (4) Its penetrating powers are far superior.
- (5) It is applicable to all kinds of tissues besides nervous ones.

The accompanying microphotographs, Figures 1 and 2

(magn: $\times 7\frac{1}{2}$) illustrate the results obtained by the two methods. They are from a case of syphilis of the centralnervous system, the two main lesions being a gumma in the left motor area and a pachymeningitis in the lower dorsal region which resulted in a compression myelitis.

As the two lesions were progressive both methods yielded positive results.

Fig. 1. Pal-Kultschitzky. Motor decussation.

Fig. 2. Marchi-Busch. Level just below the former.

In both a descending degeneration of the left direct pyramidal tract and right crossed pyramidal tract can be seen, as well as an ascending degeneration of both direct cerebellar tracts and both postero-median tracts. It is obvious from the illustrations that the descending degeneration is older and more severe than the ascending one.

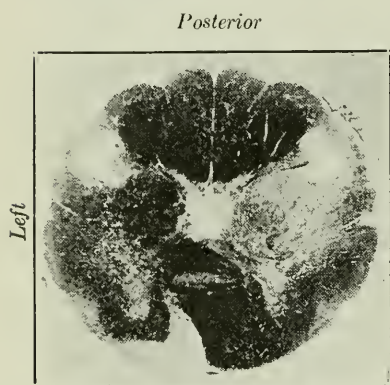


FIG. I.



FIG. II.

Figures 3 and 4 are actual size illustrations of the method of mounting. Fig. 3 is from a case of disseminated sclerosis and Fig. 4 from a case of subacute combined degeneration. The method of staining is the Pal-Kultschitzky one described in this paper. The bottom row in each case has been counterstained with alum-carmin.

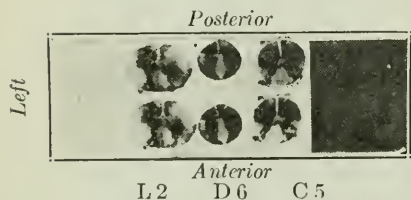


FIG. III.

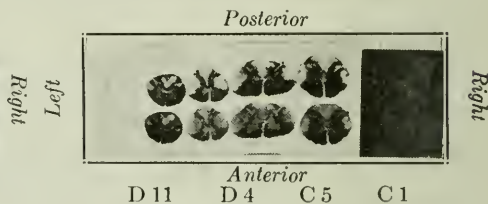


FIG. IV.

WARTHIN'S MOLASSES PLATE METHOD AS APPLIED AT LAKESIDE HOSPITAL, CLEVELAND, OHIO*

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This method was the gradual outcome of successive attempts made by many investigators working with various materials to perfect a means of staining numerous sections at one time. The great advantage of such a method is the speed with which many slides can be prepared for teaching purposes, or for routine diagnosis of tissues in a hospital where much surgery is being done. Warthin's method was published in the *Journal of Medical Research*, 1912, Vol. XXVI, pp. 39 to 46. His method, with but little modification, has been followed at Lakeside Hospital since October, 1918. During that time about sixty thousand slides were produced from surgical and autopsy material. For routine diagnostic purposes sections made by this method have been very satisfactory and the method is recommended highly as a most efficient and rapid one for producing large numbers of sections.

Briefly, the method is as follows: Fixation, hardening and embedding of the tissues are accomplished by the usual methods. As the sections are cut from the paraffin blocks they are floated satiny side downward on a 10% solution of New Orleans molasses kept constantly at 45° C. in an agate pan on a tripod near the microtome. A glass plate, perfectly clean, is immersed in the molasses solution and the sections are floated onto it. Sections are manipulated by means of a camel's hair brush, and sixty or more can be mounted on a single 5 x 7 inch glass plate,—the number depending, of course, on the size of the blocks of tissue. The glass plate is marked for identification with a wax pencil on the same surface upon which the sections are mounted. The section-covered plate is placed in the drying oven at 37° C. for one hour or more. We have found one hour sufficient. If a more rapid method is desired, drying may be accomplished very quickly over the Bunsen burner, but this requires experience. When dry, the section-covered plate is immersed in two xylols for five minutes each, and in two absolute alcohols for the same amount of time. As soon as the plate is removed from the alcohol, without allowing

*Presented at the 14th Annual Meeting of the American and Canadian Section of this Association, Cleveland, Ohio, March 24th, 1921.

it to dry, Squibbs collodion, or the preparation of collodion, alcohol and ether mentioned by Warthin, is poured over the sections. Experience teaches one to produce a thin, yet, strong film. The collodion is allowed to set for a few minutes and then the plate is immersed in luke-warm water. If the glass plate was clean, the film will separate from it very easily and will include all the sections as well as the wax pencil marks for identification. The film is now put through the stains in the usual way and is handled as if it were a single section. Washing, dehydration and clearing are carried out by any desired method. Finally, the individual sections are cut out of the film by means of a paper-cutter's wheel and mounted with the collodion surface down. The collodion does not retain any of the stain, and if thin enough, gives a flat preparation from which even photomicrographs can be made. For routine diagnostic purposes this is a very satisfactory rapid method for producing large numbers of sections.

NOTE ON THE PREPARATION OF TREMATODES AND NEMATODES FOR MICROSCOPIC EXAMINATION*

F. SLATER JACKSON, M.D.

Montreal

For the preservation and mounting of trematodes, and as an aid to their study and identification, the following methods have been found satisfactory.

(1) EXAMINATION OF FRESH MATERIAL

Living and fresh specimens may best be freed from mucus and debris by shaking in normal salt solution until clean. They may then be compressed between two slides and examined in salt solution or dilute glycerin.

(2) FIXATION

Fixation may be effected by pouring the fixing fluid directly upon the specimens, if it be desired to preserve as nearly as possible their original form. If, however, it is proposed to mount them for microscopical examination, it is preferable to compress them

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

lightly between two glass slides, by means of two rubber bands or with small wire clips. Too much pressure is to be avoided.

The specimens, or slides between which they lie, are placed in one of the following fluids:

(1) Hot mercuric chloride (saturated aqueous solution, with or without the addition of 5% glacial acetic acid). In this the specimens remain for several hours, and overnight in 70% iodized alcohol, and are finally preserved in 80% alcohol.

(2) Chrom-acetic acid (chromic acid 1%, glacial acetic acid 1%).

(3) Bouin's fluid (picric acid, saturated aqueous solution, 75; Formalin 20; Glacial acetic acid 5). Subsequent treatment with 70% alcohol until free from picric acid; preservation in 80% alcohol.

(4) Formalin-sugar solution (sugar 10 parts, formalin, 2 parts, water to 100 parts). This has the advantage of preserving the specimen without undue hardening, so that they may be studied without further preparation.

(3) STAINING

This is best carried out by transferring the slides between which the specimen lies, to a Petri dish, and submerging them in alum cochineal. In this they should remain until the specimen is much over-stained. They are then rinsed with water, which must be allowed to run between them, and thus reach the specimen which may at this stage be removed from between the slides, and placed in acid alcohol (70% alcohol, 100 c.c., hydrochloric acid 5 drops), and allowed to remain until the colour is almost entirely discharged, from the superficial parts. The preparation is then rinsed with 70% alcohol, followed by water, and replaced in the stain until the superficial parts are again faintly stained.

After again rinsing with water and 70% alcohol, dehydration is carried out in one of the usual ways, *e. g.* through absolute alcohol, carbol-xylol, etc. and the specimen is finally mounted in Canada balsam. It will be found that the deeper structures are well stained and visible through the more lightly stained superficial tissues.

(4) SECTIONING

Should Sections be desired the material may be fixed in the author's nematode fluid (90% alcohol 80 parts, formalin 10 parts, glacial acetic acid 10 parts). In this mixture specimens, if small, may remain for twelve hours.

If large, they should be cut into small pieces in order to facilitate penetration and left for a similar period. They should then be transferred to 80% alcohol, which should be changed at least once. They may then be dehydrated in the usual way, and embedded in paraffin. Sections may be stained by any of the well-known methods; haematoxylin followed by Van Gieson's picro-fuchsin gives good results.

CANCER CELLS IN PLEURAL FLUID*

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Paraffin sections may be made from many fluids obtained by paracentesis. Many specimens are sent to the laboratory without a suggestion of the clinical history in the case and usually, if the specimen is a fluid, a simple request to make a differential cell count and a direct smear for organisms is made, which, with the poor and hasty fixation of the slide, causing overlapping of some of the cells, renders it difficult to distinguish between some of the elements present. In view of this, competent and careful laboratory service is not rendered unless one tries by every known and reliable test to reach a diagnosis of a case sent in for observation.

Some laboratory workers are prone to follow the routine form of examination for all material sent them and hesitate to try out some experiment which might be suggested by a given case in hand.

The cases outlined in this brief presentation are such as might come up in the ordinary routine laboratory service.

CASE I.

The material in this case was discovered fortuitously. During the process of a pleural paracentesis, the needle became plugged and the plug was blown out on the slide, fixed and stained by the alert interne, showing a collection of cancer cells from the pleura. Autopsy revealed metastatic carcinomata in the lung.

CASE II.

The pleural fluid in this case was taken from a woman about

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

50 years of age, who had had a radical operation for carcinoma of the breast about five years previously.

There was no indication of recurrence, until a pneumonia was contracted, which left her with pleurisy and a periodic filling of the chest with fluid necessitating frequent "tappings," which, with the clinical treatments were only palliative. She lived about two years after the first paracentesis.

CASE III.

This specimen of pleural fluid was received at the laboratory with a request that a "T. B. stain and differential cell count" be done; the clinical history was that of tuberculosis.

Not being satisfied with the negative findings of the differential count and the "T. B. stain," but impressed with the peculiar staining characteristics of many of the cells present in the direct smear, some of which showed distinct alveolar formation with deeply staining nuclei, further investigation was suggested. We reported "probable adeno-carcinoma." The X-ray report the following morning was that of a "mediastinal tumour."

The fluids of Cases II and III, were bloody, cloudy and contained flocculent shreds. They were allowed to settle out and the supernatant fluid decanted. About 50 cc. of the residue were fixed with 10% formalin and centrifugalized. The shreds and fibrin formed a net in which many of the cells were caught, making it an easy task to carry the specimen through the usual stages of fixation and imbedding in paraffin.

The method as given in Professor Warthin's "Practical Pathology" for rapid paraffin sections was carried out with slight modifications as follows:

- | | |
|--------------------------------------|-----------------|
| 1. Formalin, 10% | 20-30 minutes |
| 2. Wash in water (few seconds) .. | 20-30 minutes |
| 3. Alcohol, 95% | 20-30 minutes |
| 4. Acetone | 30 minutes |
| 5. Chloroform | 30 minutes |
| 6. Paraffin, 52-55° C. (2 changes) . | 30 minutes each |

(If one will pour the liquid paraffin into a petri dish and huddle all of the large fragments of shreds together, when cooled on ice, a perfect block may be cut out and mounted for section).

The diagnosis of cancer from direct smears is hazardous, but when one has made thin paraffin sections of suspected material and their evidence is fortified with some confirmatory clinical data, positive diagnosis may often be obtained.

BACTERIOLOGICAL TECHNIQUE

THE PRESERVATION OF STOCK CULTURES OF BACTERIA BY FREEZING AND DRYING*

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(From the Hospital of the Rockefeller Institute, New York City)

The object of this communication is to present the results of the prolonged preservation of stock cultures of bacteria after freezing and drying, and to describe the method used for this purpose.

The desirability of a method that will assure the preservation of cultures of bacteria without frequent manipulation is self evident. In institutions where numerous strains of bacteria are kept, the cost of material and of labour devoted to this work is often very great. As type organisms are isolated or identified it is desirable to keep the original state of virulence or retain their cultural characteristics. In addition to the danger of contamination from frequent manipulation, there is the well known tendency for many bacteria to lose their virulence or other biological characteristics from repeated transfers on artificial media. During the course of many investigations it is often of advantage to keep all of the bacteria isolated until there is time for more detailed study. A method that will permit the shipping of cultures from one city or country to another without bulk of culture media or without danger of breakage or death of the bacteria, has obvious advantages.

The principle of keeping bacteria in a dormant state by desiccation after freezing has been known for several years. Shackell¹ was one of the first to call attention to the advantages of this principle. He showed, first, that after freezing, substances such as tissue could be uniformly dried; second, that serum retained its complement and antibody activity unaltered for weeks; and third, that rabies virus in rabbits' brains did not lose its virulence when kept in this manner. Hammer² dried bacteria previously frozen on strips of filter paper, and kept them from 54 to 57 days. Controls, dried without freezing, were killed immediately. Shattuck and Dudgeon³ showed that organisms dried on

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

¹ Shackell, L. F., *Am. Jour. Physiol.*, 1909, xxiv, 325.

² Hammer, B. W., *Jour. Med. Research*, 1911, xix, 527.

³ Shattuck, S. G., and Dudgeon, L. S., *Proc. Royal Soc.*, 1912, lxxxv, 127.

charcoal without freezing were usually killed in from 4 to 40 days. *B. pyocyaneus*, however, lived for at least seven months. Macfadyen⁴ and Macfadyen and Rowland⁵ demonstrated that practically all bacteria as well as yeast could be frozen and reduced to a temperature of liquid hydrogen, *i.e.*,—252 degrees Centigrade, and after this treatment could be recovered in a viable and unchanged condition. Rogers⁶ finally applied this principle of freezing and drying on a large scale so that mass cultures of lactic-acid-forming bacilli could be preserved for commercial purposes. He suggested the use of this method for the preservation of stock cultures for the laboratory.

For the past six years we have been using this method in the preservation of stock cultures of streptococci and pneumococci. Recently upon attempting to recover them it was found that if they were originally prepared under proper conditions, they are viable after a period of from 2 to 4 years. Comparison of the tubes from which the organisms could not be recovered with those from which they were easily grown, showed that the physical state of the dried material had much to do with the viability of the organisms. For example, in twenty-two different tubes in which it was possible to recover bacteria, nineteen were in a condition of "dry foam" and three in a condition of "flaky foam." Among eleven in which there was failure, nine were distinctly gummy, one showed a "flaky gum" and one a "dried foam." This physical state with the accompanying success or failure was present immediately after the organisms were dried or after four years. The results showed that it was necessary to maintain the frozen state until drying was complete; this led to the devising of the present method in which the tubes are immersed in glycerin that acts as a medium for the conduction of cold from a salt-ice mixture.

METHOD

Apparatus. See Figure 1.

A desiccator (D) is chosen with broad opposing surfaces on cover and stopcock. It is usually necessary to regrind all opposing glass surfaces. On the inner side of the desiccator is fastened with adhesive plaster a small mercury manometer (M) with one open and one closed end. In the upper part of the desiccator is a receptacle (R) for the desiccating salt; if phosphorus (PH.) pentoxide is used this container can be of copper. In the bottom of

⁴ Macfadyen, A., *Ibid.*, 1900, lxvi, 180.

⁵ Macfadyen, A., and Rowland, S., *Ibid.*, 1900, lxvi, 488.

⁶ Rogers, I. A., *Jour. Infect. Dis.*, 1914, xiv, 100.

In this case it is necessary to scrape off the growth into a small amount of condensation water or of broth that has been added, and subsequently pipette the suspension into tubes. We have found it convenient to use small tubes, about 10 cm. long and from 5 mm. to 10 mm. in diameter.

Manipulation.—After the culture has been placed in the small tubes as above described, the desiccator containing the glycerine is set in the pan containing the salt and ice mixture; the tubes as well are immersed in this mixture and the culture frozen (position T 1, Figure 1). Simultaneously the temperature of the glycerine is reduced to minus 4° to 6° C. After careful lubrication of the desiccator cover and stopcock and after the glycerine has reached a proper temperature and the bacterial suspension is well frozen, the tubes are immersed in the glycerine (position T 2), the phosphorus pentoxide is put in the copper pan and the cover placed securely on the desiccator. The air is then exhausted from the desiccator, first with an ordinary water pump and finally with the high vacuum pump; all of the time the desiccator is kept in the salt-ice mixture. When the proper degree of vacuum has been obtained the whole apparatus is placed in the icebox where it is left until desiccation is complete.* This time, in our experience, is usually about 12 hours. When it is certain the desiccation is complete, the tubes are removed from the desiccator, the cotton stoppers pushed down into them and melted paraffin poured in until they are thoroughly sealed. It is usually necessary to paraffin the tubes two or three times in order to insure complete sealing. If it is desired to keep the organisms for many years the tubes may be sealed by melting and fusing the open ends of the tubes. The tubes should be well labelled, after which they can be kept at room temperature; it is advisable to keep them in the dark.

The appearance of a properly dried culture is that of a very light, spongy, flaky material. If it is separated from the sides of the tube, it can be shaken about and has the appearance of dried lather made from shaving soap.

Recovery of Organisms.—The organisms may be recovered in one of several ways. For such bacteria as the cocci, and those of the colon, typhoid and dysentery group, as well as other organisms that grow easily in broth, after the removal of the stoppers, broth may be added directly to the dried powder and incubated. Organisms like meningococci or others that grow better on solid media are best recovered by picking up a small amount of the dried

*If a "frigo" icebox is available, it is advisable to place the desiccator in a temperature below zero.

material on a platinum loop and smearing it over the surface of suitable media, after it is moistened in the water of condensation.

Summary.—Attention is called to the fact that bacteria may be preserved for a long time by desiccation in the frozen state. It has been shown that it is necessary to maintain the frozen condition until desiccation is complete; if the fluid melts before the moisture is completely removed, the organisms are killed, probably because of the concentration of the salts upon the surface of the bacteria. It has been shown that by the simple expedient of immersing the tubes containing the organisms in glycerine contained in a desiccator and subsequently keeping the whole apparatus in a salt-ice mixture until drying is complete, the organisms are easily maintained in the frozen state, and dry properly. Bacteria preserved in this manner retain their cultural, biochemical and immunological characters for prolonged periods.

NOTE ON THE PRESERVATION OF CULTURES FOR EXHIBITION PURPOSES

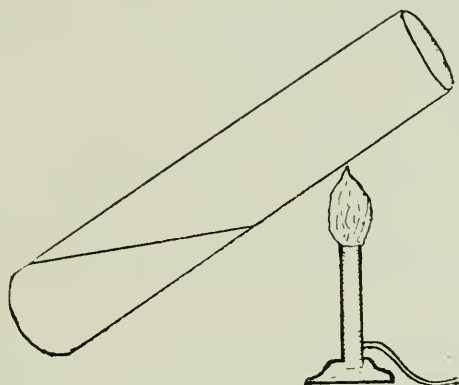
FRANCIS B. JONES, M.D.

Lecturer on Hygiene, McGill University

The accompanying exhibit of cultures is part of that to be found in the Hygiene Museum at McGill University and which had been prepared in the year 1906. They have been on exhibition since they were prepared without any alteration or modification being made to them. While there was no attempt made in the preparation of them to maintain or preserve the colouration of the colour-producing organisms, the growths and agar medium are in an excellent state of preservation after having stood for so long a time. Naturally I feel justified in bringing before this Association the method adopted by me in the preparation and preservation of them; which was as follows:

Large test tubes were used as culture tubes in order that there would be a large quantity of agar present so that it would not dry out too quickly. The nutrient agar-agar slants were inoculated with the various organisms usually used in instructing the student in bacteriology. These inoculations were grown at 37.5° C. for 48 hours. Then the cultures were allowed to stand for another 48 hours in a dark cupboard at the ordinary room temperature for two reasons—firstly, to allow the excessive moisture to dry out and secondly, to permit the colour-producing organisms time and

opportunity to produce the maximum amount of colouration. At the end of the specified time the upper free part of the tube was warmed over a bunsen flame, as shown in the accompanying sketch, to bring about the rarefaction of the contained air or, in other words, to create a partial vacuum in it after the rubber stopper had been introduced and the glass cooled down so that the stopper would be firmly held in place by the atmospheric pressure



or otherwise it would likely have been loosened by the varying changes in the temperature to which the tubes have been exposed. During the warming process the tube was rotated to obtain the maximum amount of rarefaction of the air in it.

When this operation had been completed 3-5 drops of a 40% solution of formaldehyde were allowed to trickle down the side of the tube which was volatilized by the warm glass. The rubber stopper, previously being lightly coated with vaseline, was quickly introduced with a screw-like motion so that the binding effect of the rubber against the glass sides of the tube would be best attained.

More recently the method adopted by me for the preparation of cultures for museum exhibits is to follow the same principles in growing the organisms, but instead of using formaldehyde solution as formerly I have been using neutral formaldehyde gas produced by the addition of caustic soda to the formalin solution which is then boiled in a digestion flask and the formaldehyde gas is allowed to enter the culture tube from a glass nozzle for a minute or so after which the upper part of the tube is heated in a bunsen flame as formerly described.

I find by first treating the gas as mentioned that it does not exert the same detrimental action on the colouring formed by the

colour-producing bacteria. In place of formaldehyde gas I have used a few drops of chloroform to destroy the bacterial cultures which are of the more or less slightly pathogenic or non-pathogenic varieties, with very good results, thereby preserving the colours produced by the bacteria much better than when the formaldehyde is used.

CLARIFICATION OF CULTURE MEDIA WITHOUT EGG ALBUMEN*

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Lecturer on Hygiene, McGill University

The well known culture medium nutrient gelatine as directed to be made according to the formula of Koch and Löffler is as follows:

One pound of beef-steak is freed of fat and minced. It is digested with 1,000 c.c. of water, which is then slowly raised, with stirring, to the boiling point. The infusion is then strained through muslin, after which 5 grams. of sodium chloride and 10 grams. of peptone are added; the mixture is then boiled for 5 minutes. The liquid is now carefully neutralized with a solution of sodium carbonate and then rendered just faintly alkaline. The broth is now poured into a large flask, to which has been added previously 100 to 120 grams. of the finest colourless leaf gelatine. The gelatine is allowed to soak for an hour or so, when the flask is immersed in a water-bath until the gelatine is perfectly dissolved. The reaction of the mixture is again carefully tested with litmus, to see if it still remains just alkaline. Owing to the loss of water by evaporation the volume of the medium should be noted, and hot water added until the volume is about 1,000 c.c. The mixture is now cooled, and the white of one or two eggs is carefully and thoroughly mixed in with the gelatine solution, which is then heated in a boiling water bath for 15 minutes or until the whole of the albumen has been precipitated. The gelatine is now filtered through a double pleated filter paper previously moistened, and kept warm by means of a hot water funnel, or better, the filter can be placed in an ordinary funnel in the steam sterilizer until the whole of the gelatine has run through perfectly clear. It will

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be found best to return the first 100 c.c. of the filtrate to the filter, when the filtrate will be found to run quite clear.

The preparation of agar-agar is carried out much along the same lines as laid down by the above mentioned authors, only that agar has to be broken up finely and is much more difficult to dissolve, *i.e.*, consuming much more time in its dissolution. It is mixed with the nutrient broth in the proportion of about 15 grams. per 1,000 c.c. and then clarified with the whites of two eggs; after coagulation of the albumen the medium is filtered as above stated. Even after it goes through the clarification process, nutrient agar is always slightly opalescent on cooling.

In laboratories where large quantities of culture media as nutrient gelatine and agar are used and at the present cost of eggs, it becomes somewhat expensive; but clarifying them by making use of the by-products, so to speak, such as the serum albumen and serum globulin which the salt and water dissolve out from the minced beef after it has been soaking for 12 hours, will materially lessen the cost of production and yield, at the same time, media which will be the equal to any that has been clarified with egg albumen.

I have used the following method for the past four years in the Department of Hygiene of McGill University:—

One pound of beef-steak is freed of fat, minced and placed in a stoneware jar over which is sprinkled 5 grams of sodium chloride, over the whole of this is poured 700 c.c. of distilled water. The container is covered and set aside in a cool place over night. The next morning, this is strained through a linen towel with moderate pressure, *i. e.*, by a wringing action produced by the hands, or the meat may be placed in a meat press and the extract squeezed out. Now 100 to 120 grams of gold label gelatine is dissolved in 300 c.c. of distilled water by heat, either by immersing it in a hot water bath or in a steam sterilizer in contact with current steam until all the gelatine is dissolved. This gelatine solution is first cooled slightly and 10 grams. of peptone are added slowly, while stirring the mixture, until the peptone is thoroughly dissolved. To this is added the 700 c.c. of watery extract of meat and the whole quantity of the mixture is brought up to 1,000 c.c. with warm water. The mixture is placed in a flask and is then heated in a water bath or steam sterilizer until the serum albumen and serum globulin have been coagulated or precipitated. The liquid solution is now carefully neutralized with a solution of sodium carbonate and rendered just faintly alkaline to red or acid litmus paper. The gelatine is now filtered either through double pleated filter paper, previously moistened, or the method which I prefer

is to filter it through a filter of absorbent cotton previously moistened; in either case it will be necessary to return the first 100 c.c. of the filtrate to the filter, when the filtrate will be found to run quite as clear as that clarified with egg albumen.

In preparing agar-agar the process is along much the same lines as that laid down for the preparation of nutrient gelatine, except that a few modifications must be made. This is carried out as follows:

Fifteen grams. of agar-agar is finely broken up and is dissolved in 500 c.c. of distilled water, by boiling it over a gas burner, until all traces of the agar fibre have disappeared. The reason for using 500 c.c. of water instead of 300 c.c. as previously used, is that the prolonged boiling necessary to dissolve the agar causes a considerable loss of water by evaporation. After this solution has cooled down slightly 10 grams of peptone are added slowly, stirring the preparation in order to facilitate complete solution. There is usually found to be less than 300 c.c. of this mixture remaining, and this is now added to the 700 c.c. of the watery extract of meat and the whole is made up to 1,000 c.c. with warm water. Again it is brought to the boiling point and kept under this condition for 15 minutes or until all the serum globulin and serum albumen are precipitated. This medium is neutralized with a solution of sodium carbonate until it shows a faintly alkaline reaction, as stated under nutrient gelatine. When the medium cools the phosphates are occasionally precipitated by the alkali. To overcome this I usually sterilize the agar or nutrient gelatine for 15 minutes before filtration and allow it to stand over night. The next day the medium is again melted and filtered. After this one will have a very clear product resulting. The reaction may again be adjusted to the final point and the medium sterilized finally for 30 minutes.

It appears that by allowing the meat to stand in contact with a saline solution, such as is formed by the 5 grams. of sodium chloride being dissolved in the 700 c.c. of water, a more complete solution of the clarifying bodies, serum albumen and serum globulin, is brought about; these substances being contained in the meat obviate the necessity of using egg albumen for clarification.

Communications on Comparative and Morbid Anatomy and Pre-Natal Pathology

MORBID ANATOMY

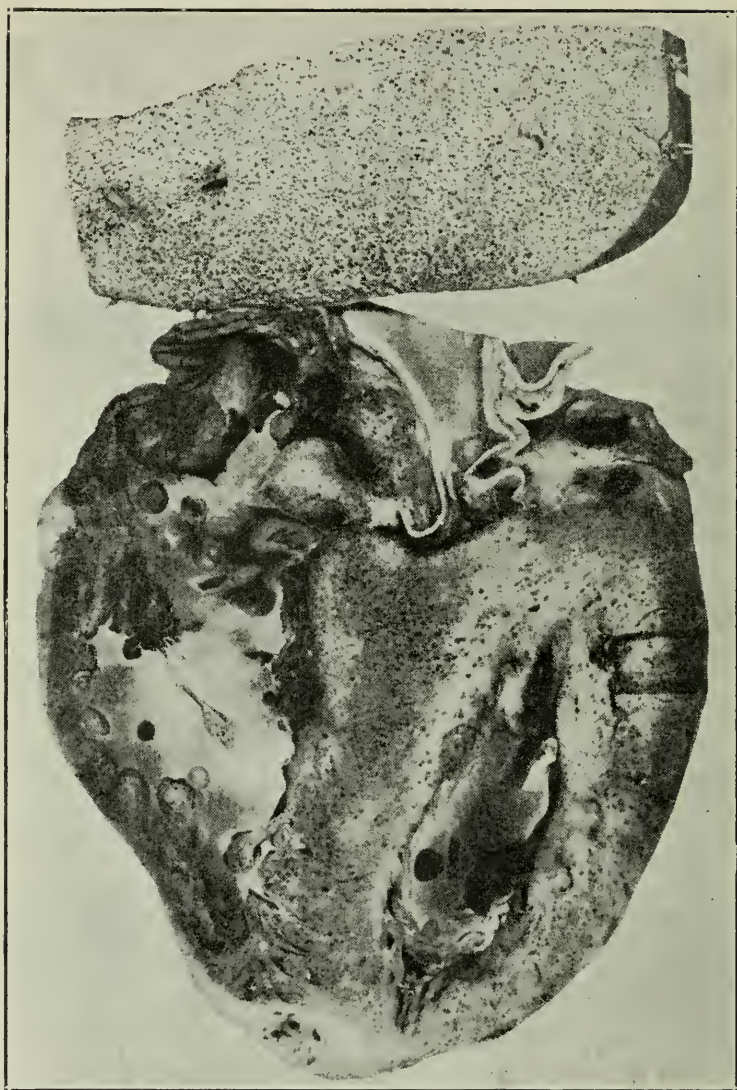
METASTASIS TO INTERNAL ORGANS IN THE COURSE OF BACILLUS AEROGENES INFECTION OF MUSCLE

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In the majority of infections unless the micro-organism has a capacity for producing an extra-cellular toxin (diphtheria and tetanus bacilli) the deleterious action of the bacterium upon the infected tissues is not apparent. Infection by such organisms as staphylococcus aureus, the various streptococci, and bacilli of the typhoid group, are noted clinically and pathologically through the reactive changes in which the tissues of the host take part. In such infections the clinical manifestations represent such tissue reactions. In a small group of infections notably in those due to bacillus aerogenes capsulatus, and bacillus fusiformis (Vincent's) the proteolytic activity of the bacterial results in visible alterations in the infected tissue.

Bacillus aerogenes also known as bacillus welchii and bacillus perfringans is an organism of but limited virulence, in so-far as this term indicates its ability to proliferate in the living animal tissues. In order that infection by this bacillus may become established it is necessary that the tissues in which the micro-organism is implanted be devitalized. In the body bacillus aerogenes capsulatus, once it has obtained a foot-hold in muscle tissue, is able to spread with extreme rapidity in consequence of its ability to destroy and devitalize contiguous muscle tissue. The organism grows well only in muscle and in the liver. Its ability to produce gas and tissue poison depends upon the presence of glycogen in the infected tissue.



Bacillus Aerogenes Infection of Liver and Heart Muscle.—F. B. GURD.
From a Specimen in the Canadian Army Medical Museum.

The manner of infection of contiguous muscle tissue in cases of established infection is readily explained by an examination of the microscopic picture. In the spreading edge of the gangrenous process the large deeply staining rods are readily made out. The muscle fibres are swollen and stain more intensely than normal with the acid stain. The muscle fibrils themselves though swollen are seen to be separated by a clear space from the sarcolemma sheaths. This clear space represents the site of either gas or gas plus a toxic fluid. Death of the muscle fibril follows this mechanical separation of the fibril from its sarcolemma with consequent cutting off of the blood supply. There is thus produced a pabulum of dead animal matter in which the infecting micro-organisms continue to proliferate.

The specimens exhibited, which are all three from the same case, are of interest since they demonstrate the marked distension with gas with consequent "bubble" formation in the heart muscle and in the liver. The spleen, which contains but little glycogen is free from vacuole formation.

Unless autopsy is performed immediately after death in cases of gas gangrene it is difficult to determine whether the involvement of the liver, heart, and of skeletal muscle apart from those originally involved had become infected prior to or immediately after death. Unfortunately, there is no note accompanying the present case which would prove that the condition seen was in truth ante-mortem. Upon several occasions the author has had under his care patients dying from gas gangrene in whom skeletal muscles and liver were positively involved with massive gas production during life. In some cases the body though still alive, became swollen to twice its normal size.

(A) LIVER, GAS GANGRENE, METASTATIC. FOAMY LIVER

Specimen consists of a thin slice of liver from a case dying of gas gangrene. The liver is seen to be completely filled with vacuoles measuring in size from .5 to 5 mm. in diameter. The lining of these "bubbles" is smooth for the most part and glistening. There is no evidence of suppuration.

Micro. sections show for the most part simply a net-work of flattened liver cells, enclosing large clear spaces. The walls of these clear spaces (gas bubbles) are covered with closely packed large bacilli. There is no evidence of inflammatory reaction. For the most part the areas of liver destruction are situated in the periphery of the lobules, and from the periphery appear to have invaded the lobule.

(B) HEART, GAS GANGRENE, METASTATIC

Specimen consists of heart sectioned so as to expose the walls of the right and left ventricles with their cavities and the inter-ventricular septum. The ventricles and the right auricle are filled with a pale, greyish, brown clot in which are seen several gas "bubbles" measuring 3 to 5 mms. The myocardium is pale and everywhere infiltrated by small vacuoles measuring from $\frac{1}{2}$ to 1 mm. in diameter and smaller. In several places it is readily noted that these vacuoles are elongated in shape. This appearance as the microscopic sections show is due to gas production in individual bundles. Over the surface of the heart small gas collections are seen beneath the epicardium. The fatty tissue covering the heart and surrounding the vessels also shows a smaller number of gas "bubbles".

Micro. section: The edges of the vacuoles in the heart muscle are covered with large numbers of large, deep staining bacilli.

(C) SPLEEN

Is but slightly enlarged, is firm, brownish purple in colour. Beneath the capsule are seen one large and several smaller dark, well demarcated, areas. The cut surface is smooth (fixed specimen), brownish in colour, and presents one large and several small purplish triangular areas with the base beneath the capsule. The central portion of the brownish, dark area is apparently necrotic, being soft and friable. Throughout the organ there is no evidence of gas production.

Micro. section proves spleen pulp to be normal in appearance, free from gas "bubbles," and shows that the darkened areas are composed of necrotic spleen tissue infiltrated with red blood cells (red infaret). They do not show the presence of bacilli either in the vessels or in the tissue.

LESIONS OF THE RESPIRATORY TRACT INITIATED
BY THE INHALATION OF IRRITATING GASES*

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The following brief review is offered as a supplement to the demonstrations by Dr. C. A. McKinlay, at the meeting of the

*Presented at the 12th Annual Meeting of the American and Canadian Section of this Association, Atlantic City, N.J., June 14th, 1921.

International Association of American Museums, Atlantic City, June, 1919. The pictures that were presented are a portion of the illustrations included in the monograph entitled "The Pathology of War Gas Poisoning," Yale University Press, New Haven, 1919.

The majority of gases utilized in the recent war owe their efficiency to their irritative and escharotic action upon the respiratory tract. This causes an inflammatory edema, followed by a cellular exudate, both into the upper air passages and in the pulmonary parenchyma. The type of inflammatory reaction is largely determined by the extent of the primary destruction. Many gases produce such deep seated necroses that if death does not ensue in the acute, edema stage or at the height of the pneumonic process organization of the exudate occurs within alveoli and bronchioles. The contraction of the scar may lead to progressive mechanical difficulties not only with the ingress and egress of air into the alveoli, but also with the pulmonary circulation. Furthermore, chronic suppurative inflammatory processes, may persist, often associated with tubular, or even saccular dilatations of the bronchi.

The gases of the respiratory irritant group act similarly, but differ in the localization and extent of their necrotizing effect. A brief review of the pathology of mustard gas, chlorin, and phosgene will emphasize this difference.

Mustard gas, in lethal concentrations, not only destroys the lining of the entire bronchial tree, but its necrotizing action involves the lung itself. In more dilute form, it produces necrosis of the epithelium of the trachea, which, however, becomes less marked in the finer ramifications of the bronchi. The gas seemingly spends itself in the upper air passages. It either does not reach the bronchioles and alveoli, or it reaches them in such a diluted or changed state that chronic pulmonary lesions after this gas are rare.

After chlorin inhalation, there is also an injury to the lining of the entire respiratory tract, even to the ducti alveolares and the alveolar walls themselves. The epithelium is blistered, but the necrosis in the trachea and in the larger bronchi is not as deep and extensive as it is with mustard gas. Probably on account of its less efficient corrosive action the injury to pulmonary parenchyma, results more frequently in chronic lesions which may cause death long after the initial symptoms have passed.

Phosgene has the least severe action upon the respiratory tract, but leaves in its wake the most frequent and persistent lesions. Organization of bronchiolar and peribronchiolar exudates

with obliteration or dilatation of the lumina of the bronchi, leads to serious and progressive obstruction to the passage of air and to the circulation of blood in the lungs.

With vital stains immediate death of the epithelial lining cells of the respiratory tract after poisonous gas inhalation is demonstrable. This injury to the upper respiratory tract is the anatomical expression of the destruction of its protective mechanism. The destruction is followed by invasion of the lung by the bacterial flora of the mouth. This has been demonstrated repeatedly by cultures taken before and after exposure to poisonous gas.

The high mortality in the acute or edema stage is not due to the accumulation of fluid within the air sacs. Pulmonary edema must be regarded as the expression of a more deep seated process, and in itself is never a satisfactory explanation for death. Where death does not terminate the process in the edema stage, the inflammatory exudate which supervenes is readily explained by the presence of large numbers of bacteria that find a fertile medium for development in the trachea and lung, injured by the action of the gas.

The primary escharotic action of these gases frequently leads to much more extensive lesions of the respiratory tract. If the animal survives the necrotizing tracheitis, bronchitis and pneumonia of the acute stages, chronic processes result. The initial damage is followed by organization which may be sufficiently extensive after mustard gas inhalation to produce stenosis of the larynx or trachea. After chlorin, phosgene, superpalite, cyanogen bromide, chlorpicrin, etc., a progressive fibrosis with obliteration or dilatation of the smaller air passages may result. With phosgene this has occurred even when clinical expression of acute damage has been lacking. Obliteration of the smaller air passages leads to pulmonary emphysema and atelectasis and these cause progressive respiratory disturbances.

THE PATHOLOGY OF INFLUENZA

M. C. WINTERNITZ, F. P. McNAMARA and ISABEL WASON

Yale University, School of Medicine

The following brief summary of our study on the pathology of influenza is offered as a supplement to the demonstration by Dr. Frank P. McNamara at the meeting of the Association of Medical Museums, Atlantic City, June, 1919.

The study conducted at the Brady Laboratory of Pathology of the Yale School of Medicine, is based upon the findings in ninety-five post mortem examinations at the New Haven Hospital which is affiliated with the Yale School of Medicine. The completed work will be published later. The demonstration was designed to bring to your attention the more characteristic anatomical findings in influenza. A large number of the drawings illustrated the gross and more minute respiratory lesions associated with influenza and its complications and sequelæ. There were also presented a few of the more important influenzal lesions encountered in other portions of the body.

In all of the fatal cases pneumonia was a constant feature. It was associated with an intense, hæmorrhagic, acute tracheo-bronchitis, but the lesion was superficial in the larger air passages. In the bronchioles, however, the acute destruction was often more extensive and chronic processes—organizing pneumonia, bronchiectasis, and bronchiolitis obliterans—were encountered in cases succumbing after the acute lesions had subsided. The increase in volume and the brilliant colours of the lung were characteristic gross features. Fulminating cases showed a diffuse serofibrinous inflammatory process involving any or all of the structures of the lung. The absence of polymorphonuclear leucocytes in the pulmonary exudate, the dilatation of the bronchioles, the hyaline necrosis of their walls and also of the walls of the alveoli, the rupture of the alveolar walls with resultant interstitial emphysema, or pneumothorax, the subsequent necrotization of the pulmonic exudate and tissue with abscess formation and organization, formed the most important features of the pathology of the respiratory tract in this disease. Irrespective of localization, the extra-respiratory lesions had the same fundamental pathology; this was vascular damage, hæmorrhage, and organization with or without previous infection.

A CONTRIBUTION TO THE PATHOLOGY OF AMOEBIC
AND BACILLARY DYSENTERY*

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The pathology of amoebic and bacillary dysentery has been told and re-told many times within recent years. There still remain to be explained, however, many obscure points with regard to the causation of the morbid processes involved, and this fact renders the study of these lesions one of live interest.

During the summer of 1913 it was the writer's good fortune to work over a magnificent series of specimens of dysentery in connection with the pathological museum of this university; the paper presented gives, in outline, the main results of this work.

While this study is chiefly concerned with the histo-pathology, many other points of interest have arisen, which may form the subject of further investigation.

SOURCE OF MATERIAL

The material used in the preparation of this paper consisted of seventy-nine specimens of large intestine in amoebic, bacillary and mixed (bacillary and amoebic) dysentery, obtained from the Desert Laboratory of El Tor on the Sinai Peninsula, and presented to the Pathological Museum of McGill University, by Dr. J. Graham Willmore. They were not specially selected save with the idea of making a collection suitable for museum requirements, and should, therefore, form a series from which general deductions may be drawn, allowance being made for the comparatively small number of microscopic preparations examined. The necropsies were performed on Mussulman pilgrims who died at the quarantine station at El Tor on their way home from Mecca. Of the seventy-nine cases, forty were purely bacillary, that is to say, the infecting agent was one form or other of *Bacillus dysentericus*, B. Flexner,

[This article was written while the author was a student in the final year in Medicine at McGill and won the McGill Medical Society Senior Prize for the best piece of original research. As it states, it is based upon the examination of a fine series of gross specimens of Amoebic and Bacillary Dysentery in the McGill Museum, collected at Mount Sinai in Arabia, and should be of interest to readers of the Bulletin as constituting a valuable study in pure morphology based upon museum specimens. It was illustrated by sixteen microphotographs which could not be reproduced.—ED.]

*Presented by the author before the American and Canadian Section of this Association.

B. Shiga, and B. Tor, being the strains most often found (the last named was isolated at El Tor and described by Drs. Ruffer and Willmore in 1909). In twenty (20) cases pathogenic amoebæ were found in the stools without the presence of dysentery bacilli, and in the remaining nineteen (19) cases both amoebæ and bacilli were obtained.

The specimens were mounted, prepared and catalogued for the McGill Museum and from them a number of microscopic slides were made (and photo-micrographs taken) to illustrate various stages of the ulcerative processes obtaining in both forms of the disease.

AMOEBIC DYSENTERY

The amoebic process is essentially chronic, subject, however, to acute or sub-acute exacerbations alternating with periods of quiescence. Of the twenty (20) specimens examined two only were regarded clinically as acute; in eight others the disease ran an acute course but was associated with gangrene. The remaining specimens were of the chronic type, three without and seven with gangrene.

Pathologically no precise distinction can be drawn between acute and chronic cases, for the intestine always presents ulcers in all stages of degeneration and regeneration.

In the early stages the mucosa shows small areas of thickening, oedema and congestion, in the centre of which is seen a tiny perforation situated on the summit of a small papilla-like eminence and resembling a crater leading down to a miniature volcano. The perforations extend to form irregular slits along the valvulæ conniventes, and on inserting a flexible probe we find that the sub-mucosa is involved to a far greater extent than the overlying mucosa. The amoebæ have penetrated the crypts of Lieberkuhn, and have started a destructive process in the submucosa. As the process becomes more extensive, fistulous tracks and tunnels form and the intestine presents a worm-eaten appearance due to death and sloughing of the overlying mucous membrane. The late involvement of the mucosa explains the insidious onset of this form of dysentery and the absence of severe symptoms in many of the cases.

The older ulcers present an appearance which varies with the age of the process and the amount of degeneration or healing which has taken place. They are round, oval or irregular in outline, situated along the transverse axis of the gut with bases formed by the muscular coat or the thin, transparent serosa. Their edges are rounded, raised and tumefied, or ragged and necrotic, or

again thin and flat without any shelving where healing is taking place; extensive undermining can be demonstrated in all except the healed ulcers. On holding such an intestine to the light it presents a reticulated appearance, the ulcers forming "lakes" separated from one another by intervening bridges of relatively healthy mucosa which in some cases are supported by intact sub-mucosa, and in others are of the nature of hollow arches, allowing of the free passage of a probe from one ulcer to the other.

Except at the onset of the disease there is a striking absence of inflammatory reaction; the peritoneum is congested and the appendices epiploicæ oedematous, but there are no signs of adhesions over the advanced ulcers or even around the perforations. This offers an explanation of the frequency of perforation in this form of dysentery.

While, in the acute conditions, the gut may be thick and oedematous, in the old chronic cases the bowel is always thin and dilated; none of the specimens presented the hard, thickened, contracted appearance described by some writers as typical of chronic cases of long standing.

Gangrene is not rare in these cases and perforation is a common complication, as healing is slow and the deep lesions repair with difficulty.

Microscopic examination throws some light on the nature of the ulcerative process which takes place. Microscopic preparations have been prepared from these specimens showing the following conditions:

A.1 Catarrhal stage.

A.2 Edge of a very early ulcer.

A.3 Chronic stage (healed)

A.4 Chronic condition with secondary infection.

A.5 Gangrene with sloughing of mucosa and sub-mucosa.

A.6 Advanced gangrenous condition.

The earliest condition A.1 is one of catarrhal inflammation with degeneration and desquamation of the surface epithelium, dilatation of the glands and great increase in the number of goblet cells. The interglandular stroma exhibits evidence of inflammatory cell infiltration with dilatation and engorgement of the capillaries and lymphatics. It must be especially noted that this condition is restricted to the small thickened areas of mucosa described above (early follicular involvement).

Later the amoebæ penetrate the crypts and are seen in the interstitial tissue; their presence leads to necrotic changes in the glands and stroma of the mucosa with local destruction of blood

vessels and lymphatics. The surrounding mucous membrane remains comparatively healthy and there is no marked inflammatory reaction. The sub-mucosa is now thick and oedematous with numerous migratory cells scattered through it.

A.2—Now follows the stage of ulceration. The amoebæ are found in large numbers in the sub-mucosa, and by their activity have produced great oedema and congestion of the tissues with the pouring-out of exudate. Coagulation necrosis ensues, and this goes on to liquefaction with the production of soft necrotic masses containing numerous amoebæ and a few inflammatory cells. The blood vessels at this stage are not thrombosed. By the destruction of the submucous tissue the overlying mucosa is deprived of its blood supply and dies, secondary infection supervenes, sloughing takes place and large irregular ragged ulcers are formed.

In the old chronic cases the tissues may be destroyed *en masse* as far as the muscular coats or serosa, with little evidence of inflammatory reaction anywhere. Healing occurs with difficulty with the formation of small areas of granulation tissue along the bases of the ulcers.

B. BACILLARY DYSENTERY

The specimens of bacillary dysentery were classified according to the clinical findings in each particular case into the following groups:

- I. Acute.
- II. Sub-acute.
- III. Chronic.
- IV. Chronic with acute, or sub-acute, exacerbations.
- V. Gangrenous.

(Nearly all the gangrenous cases are complicated with nephritis, myocarditis and broncho-pneumonia, often with malignant tertian malaria as well).

Clinical Features: The following extracts are from Dr. Willmore's notes, made during life: "An *acute case* was considered to be one in which the probable date of onset was within ten days of admission. The stools in these cases usually consisted of blood, mucous, and small sloughs, preceded by a preliminary serous diarrhœa, and followed by liquid, serous, blood-stained stools, resembling water in which raw meat had been washed (raclure de boyeau). These cases usually presented signs of severe toxinæmia, as evidenced by a rapid, small pulse, high temperature (39° to 40°C.), albuminuria—though the quantity of urine was not as a rule much diminished—and prostration.

Pain of a colicky, cramping nature, referred particularly to the region over the transverse colon, was always insignificant—a condition in sharp contrast to that seen at the onset of acute amoebic dysentery.

“A sub-acute case was so classified when the probable onset of infection dated from ten to twenty days previous to admission.

“The stools usually consisted of very little muco-fæculent material, muco-pus, sloughs, and blood; often the stools consist entirely of muco-pus, giving the appearance—according as to whether they are blood-stained or not—of raspberry food or creme d’orge. The constitutional symptoms vary with the virulence of the infection and the resisting power of the patient.

“A chronic case was so classified when the probable onset of infection dated from three weeks to a month or more previous to admission.

“The stools consisted of a certain amount of brown or yellowish muco-fæces, mixed with sloughs, muco-pus and blood. The patient was usually emaciated with sometimes a varying degree of oedema of the ankles and feet, and presented signs of a varying degree of toxinæmia. The urine was usually scanty, high coloured and contained varying amounts of albumin.

“A case was considered to be gangrenous when the following conditions were present:

“The passage of extremely offensive green, greenish-brown or black stools containing altered brown blood, and green or black sloughs of varying dimensions and characters. These sloughs may be large—in some instances dark-green tubular sloughs more than a foot long were passed—or intimately mixed up with muco-pus and altered blood, giving the stool the appearance of mashed spinach, a puree of green peas, or a cup of chocolate.”

Macroscopical Appearance: The acute, chronic (with or without exacerbations) and gangrenous cases, fall respectively into well-defined groups, but it is difficult to state from the macroscopic and microscopic appearances of a given pathological specimen whether it can be classed as sub-acute or not.

In the acute cases the intestine is characterized by intense congestion, oedema and infiltration, the thickened wall enclosing a narrow and irregular lumen. The mucosa is red, swollen and puckered, and scattered diffusely over its surface are numerous patches of greenish necrotic material forming a readily detached false membrane which in many places has sloughed away leaving areas of superficial ulceration. The ulcers are confined to the mucosa and tend to extend along the projecting folds of mucous membrane rather than into the deeper tissues. They are never

undermined and though usually small and discrete may become confluent and so produce large oval or irregular losses of tissue. The early involvement of the mucosa explains in part the sudden and rapid onset of this form of dysentery.

As the condition progresses, the areas of necrosis increase in size and large portions of the mucosa may slough away, the ulcers gradually burrowing into the submucous tissue. Perforation may occur but is comparatively uncommon, the patient dying as a result of toxinaemia or from some intercurrent disease.

In the chronic cases the intestine is constricted and thin-walled, the mucosa has sloughed away in some parts and is redundant in others, with intervening areas of cicatrization.

Often the chronic course of the disease is interrupted by acute exacerbations, the last of which may be fatal. Here the large intestine presents evidence of a long-standing process, with thin wall and narrow lumen, scanty mucosa and numerous healed and healing ulcers. Side by side with this condition will be seen lesions produced by an acute exacerbation, the portion of the gut involved being thick and constricted, with deeply congested mucosa thrown into warty projections and puckered by the contraction of intervening scar tissue. Small superficial ulcers and discrete patches of necrotic false membrane are well seen.

In all cases of bacillary dysentery, except the old chronic conditions, the peritoneum is markedly congested, and in cases of perforation, or when the ulcers have burrowed deeply, there are often signs of peritonitis with the formation of adhesions.

The *microscopical appearance* of the lesions are well presented in preparations numbered B.1 to B.8, which show various stages in the process of ulceration as follows:

B.1 Catarrhal stage.

B.2 Preulcerative stage.

B.3 Early ulceration.

B.4 Height of disease.

B.5 Height of disease.

B.6, 7 and 8 Gangrene.

In the earliest stages (B.1) there is a more or less mild grade of catarrhal inflammation which differs from that of the amoebic infection in the diffuse generalised involvement of the bowel wall and in the absence of pathogenic amoebæ.

As the disease progresses (B.2 and B.3) the catarrhal condition becomes more prominent, many of the glands having the appearance of mucous cysts. Inflammatory reaction is marked in

the mucosa and there is a great deal of interstitial hæmorrhage. The submucosa is oedematous and congested.

In the height of the disease (B.4 and B.5) catarrhal inflammation gives place to necrosis and superficial ulceration, accompanied by marked inflammatory cell infiltration (polynuclears predominating) and multiple extravasation of blood throughout the interglandular stroma. There is now thrown out a thick exudate of coagulable proteid material sealing off the fundal remains of the crypts of Lieberkuhn and enclosing amongst its fibrinous meshes numbers of dead and dying leucocytes with fragmented bodies and disintegrated nuclei.

The cause of this coagulation necrosis has been stated by Flexner to be the elimination of toxins through the large intestine these toxins having been absorbed in the small bowel and carried to the large intestine by the blood stream. On this assumption it is difficult to explain why there are no lesions in the small intestine, and why the ulceration in the large bowel proceeds from the mucosa inwards. On this account it seems probable that in addition to the general toxinæmia which undoubtedly exists, the bacteria exert a local toxic action on the glandular epithelium in the large bowel.

The muscularis mucosæ is either entirely lost or necrotic. The submucosa is oedematous and greatly congested with widely dilated vessels, which are thrombosed; the thrombosis is not constant enough to be the cause of the coagulation necrosis. Inflammatory cell infiltration is greatest in the neighbourhood of the muscularis mucosæ. The lymph follicles are not markedly enlarged.

Subsequently, healing may take place or the condition may progress to perforation of the bowel, or gangrene may supervene. In the first case the bowel wall remains thick and puckered except in long-standing chronic disease, but the glandular elements are never restored.

C. MIXED (Amoebic and Bacillary) DYSENTERY

Nineteen of the specimens examined presented lesions due to a bacillary process superimposed on a chronic amoebic process. The knowledge that mixed infections do occur, and occur frequently, has an important bearing on the treatment and prognosis of any given case. "The mere presence of pathogenic amoebæ in the stools, while absolutely diagnostic of amoebic ulceration, does not exclude the possibility of a coexistent bacillary infection."

These specimens are, perhaps, the most interesting, for they prove beyond question the specific nature of the lesions produced by each type of infection. One specimen shows 'amoebiasis' existing side by side with bacillary infection, neither encroaching on the other's territory; the former presenting the characteristic deep undermined ulcers and giving rise to a thin dilated gut, the latter making itself known by diffuse areas of superficial ulceration, congestion of mucosa, and extensive scarring producing a rough, warty, contracted bowel. Another specimen shows the bacillary infection superimposed on a chronic amoebic process; in this the intestine becomes thinned in places, irregularly corrugated in others, here dilated, there constricted, pale or congested, according to the nature of the process. In this connection it is worthy of note that perforation generally takes place at the sites of amoebic ulcers.

To Summarize

I. There were seventy-nine (79) specimens of large intestine examined and classified as follows:

AMOEBIC		BACILLARY		MIXED
Acute	2	Acute	6	Chronic amoebic
Chronic	3	Sub-acute	9	with superim-
Acute with gangrene	8	Chronic	11	posed—
Chronic with "	7	Chronic with exacer-		Acute or sub-
		bations	7	acute bacillary
		Acute with gangrene	4	Chronic bacillary
		Chronic with "	3	Recurrent bacil-
				lary
				Sub-acute bacil-
				lary with gan-
				grene
Total	20	Total	40	Total
				19

II. Gangrene occurred in 75% of amoebic cases, 17.5% in bacillary cases, and in 5% of the mixed cases.

III. Perforation was the cause of death in the following proportion of cases:

AMOEBIC—9

Chronic cases	2
Acute gangrenous condi-	
tions	2
Chronic cases with gan-	
grene	5

Total

9
Of the three chronic amoebic cases two had single perforations; the other was extremely thin in one area (impending perforation).

BACILLARY—0

There were no actual perforations in this group but two of the chronic cases with gangrene showed areas of tissue paper appearance (impending perforation).

Of the eight acute gangrenous cases one showed a single, another multiple perforations, while a third specimen, though not perforated, broke with its own weight on being removed from the body at autopsy.

In the seven chronic cases complicated with gangrene two had single and three multiple perforations, while another specimen showed an area of impending perforation.

In the cases of mixed amoebic and bacillary dysentery there were two specimens showing perforation, and one with extreme thinning, one of the former being the case associated with gangrene. Both perforations occurred at the sites of amoebic ulcers.

It is curious to note that the perforations generally occurred through one of the longitudinal bands of muscle, where the intestinal wall might be supposed to be strongest.

IV. General appearance of intestine:

AMOEBIC

- (a) Thin and dilated as a rule with little cicatrization.
- (b) Mucosa and peritoneum slightly congested; no peritoneal adhesions.
- (c) Ulcers discrete and burrowing deeply.

BACILLARY

- Thick, contracted, and puckered by scar tissue.
- Mucosa and peritoneum greatly congested; peritoneal adhesions often seen.
- Ulcers superficial and diffusely scattered over the mucosa.

V. The outstanding difference between the two processes seems to be that while the bacillary infection is sudden in onset, and gives rise to frank inflammation and active reaction on the part of the tissues, the amoebic process is insidious in onset, pursues a chronic course, and results in necrosis without any marked signs of inflammatory reaction.

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HYDROCARBON FIBROMATOSIS

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The occasional development of a peculiar connective-tissue reaction after the subcutaneous injection of fluid or semifluid hydrocarbons is well recognised. The usual term by which this reaction is known is rather an unfortunate one, for "paraffinoma" proclaims unmistakably that the condition is of a neoplastic nature, and this is by no means the case. It is essentially a reaction on the part of the tissues to an irritant of the nature of a foreign body, as is evidenced by the abundant formation during the active stage of typical foreign body giant cells. At a later period the formative granulation tissue is replaced by dense fibrous tissue.

Most of the cases have been due to the use of semifluid preparations of wax injected for æsthetic purposes, but there are recent examples in the literature of a similar condition following the subcutaneous injection of adulterated preparations of camphorated oil, in which olive oil has been replaced by liquid petrolatum. An interesting example of such an occurrence was described recently by Stokes and Scholl.¹ In the present case some form of vaseline appears to have been used.

History. The patient, a lady of middle age and of quite reasonably good looks, developed an ardent desire to add to her personal charms. The presence of a rather deep depression above each eyebrow induced her to consult a beauty specialist, who treated her with about 20 injections of a greasy preparation resembling vaseline. All went well at the time, the depressions disappeared, and the lady left the city. Some months later she noticed a change occurring in her cheeks and about her eyes, the principal feature being a thickening of the tissues progressive in character and extreme in degree. The lower portion of each cheek swelled out until she had the jowl of a prize-fighter, and the tissue proliferation below the eyes was so great that the eyes were nearly closed. When she was seen in Winnipeg a year later she was an object for pity rather than for admiration.

Microscopical Examination. Much of the thickened tissue was removed, and the microscopic picture was one of considerable

¹ Stokes, J. H., and Scholl, A. J.: A Case of Probable Paraffin-oil tumour. *Arch. Dermat. and Syph.*, 1921, IV, 51.

interest. In a section removed from the lower part of the cheek the first thing to arrest attention was the presence of a large number of regular spherical spaces, varying considerably in size, but the majority no larger than the convoluted tubules of the kidney. A few, however, were at least ten times that size. These spaces evidently represented the droplets of paraffin which had made their way downwards from above the eye. They were contained in well-formed fibrous tissue, which in places was very dense. Here and there the fibrous tissue constituted a very definite capsule which surrounded one or more of the spaces. Throughout the entire section there was evidence of a cellular reaction, although evidently the cellular was giving place to the fibrotic stage. For the most part the cells were scattered diffusely and sparsely, but in places they were grouped in small foci strongly reminiscent of the active stage of a syphilitic lesion. Under the high power it was with surprise that one noted that the cells were all lymphocytes. There were no epithelioid cells and no giant cells. From both the gross and the microscopic description it is evident that the term fibromatosis describes the condition much more accurately than does paraffinoma.

Why the injected material should migrate in some cases, and why in some cases and not in others it should produce such marked irritation it is hard to say. The after-effects may be delayed for a considerable period, as in the present case. Kolle² records a case where olive and almond oil was injected into the suprasternal notch. Five months later the part became tender, inflamed, and began to enlarge daily. Eventually a huge, hideous hyperplastic mass developed in the neck, five inches in its horizontal diameter and three and a half inches in the vertical.

² Kolle, F. S.: *Plastic and Cosmetic Surgery*, 1911, p. 254.

PARASITOLOGY

BELASCARIS CATI: AN OCCASIONAL HUMAN
PARASITE*

J. S. HENRY

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Several cases have recently come under the writer's observation in which kittens exhibited marked emaciation, with frequent vomiting, followed by death after a varying period of illness. In one of these cases a post mortem examination was made, and the duodenum was found to be filled with nematode worms, so closely packed as almost completely to occlude its lumen.

These proved to be *Belascaris cati*, a well-known parasite of the cat, and of interest inasmuch as it has been reported in some eight or nine cases as occurring in man, for which reason the following brief note is submitted.

Synonyms:—*Belascaris mystax*, *Ascaris mystax*, *A. marginata*, *A. alata*.

Description:—This species is characterized by the possession of conspicuous cephalic "wings". The male is 3-6 c.m. in length, the female 4-10 c.m. The copulatory spicules of the male measure 1.7 to 1.9 mm. in length.

Life history:—This has recently been reinvestigated by F. H. Stewart, I.M.S. (*Parasitology*, vol. 10, 1917-18, pp. 193-196.).

He states that the development of the ovum takes place in water or damp earth, and quotes Davaine as saying that the ovum may develop in a dry condition.

Leuckart's experiments seemed to show that infection was not direct, although he failed to find an intermediate host.

Stewart experimented with mice, feeding them with ripe ova, and found larvæ in the liver between the first and third days after infection, and also recovered them from the fæces.

Occurrence in man:—(1) Dr. Pickells described a number of ascarids vomited by an Irishman, aged 28, in 1822. In his article (*Trans. Assoc. of the Fellows and Licentiates of the King and Queen's College of Physicians in Ireland*, vol. 4, 1824, pp. 189.), he says that it closely resembles the *Ascaris* found in the cat.

(2) Dr. Bellingham of St. Vincent's Hospital, Dublin, described two worms brought away from a child five years of age by

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

a vermifuge, and named them *Ascaris alata*. These two cases were held in suspicion by Diesing, Kuchenmeister and others, who maintained that the worms observed were probably immature specimens of *A. Lumbricoides*. (*Vide Dublin Medical Press*, February 20th, 1893, and *Annals of Medical History*, vol. 13).

(3) Dr. T. Spence Cobbold, of the Middlesex Hospital, London, (*Lancet*, 1863, i; pp; 31-34) described specimens evacuated by a child of thirteen months. He identified them with *A. mystax* of the cat, and states that the worms described in the previous cases were of the same species.

(4) Leuckart described specimens of *Belascaris cati* coughed up by a German peasant woman, twenty-eight years of age. Of these worms, six were females and one was a male; none were fully developed.*

(5) A single female specimen was coughed up by a woman in Greenland, and sent to Leuckart for identification.

(6) Dr. T. Morton reported the finding of a single female which had been evacuated by a child of 14 months at the Kilburn Dispensary, London. (*Lancet*, 1865, i; p. 278).

(7) Dr. Böhm reported a single female evacuated by a young child. (*Ziemssen's Cyclopedia*, Amer. Ed., vol. 3, p. 751).

(8) A case reported by Grassi is cited in Kuchenmeister, *Parasiten des Menschen*, 2nd. ed., 1879, p. 413.

(9) In 1884, Dr. Howard Kelly, of Philadelphia, reported (*Amer. Jour. Med. Sci.* 1884, 88, p. 483) twenty-five specimens vomited by a woman.

*"Die Menschlichen Parasiten," 1876, Bd. 2, p. 258—2nd. ed., p. 412.

MONSTROSITIES

A CASE OF CONGENITAL ABSENCE OF BOTH FORE-ARMS SIMULATING PHOCOMELUS*

GUTHRIE McCONNELL, M.D.

From the Laboratory of the City Hospital, Cleveland, Ohio

From a rather cursory examination of the literature, the following case seems to be distinctly unusual, if not unique. The external appearance is such that the term "phocomelus" seems most appropriate, yet an examination of the radiograms indicates

*Presented at the fourteenth Annual Meeting of the American and Canadian Section, New York, 1920.

that the case is not a true one of that type. In a true case of phocomelus there is a congenital absence or an incomplete formation of the proximal segments of a limb, with or without marked deformity of the hands or feet.

The present case was that of a white woman, M. S., 34 years old, married. Unfortunately, no history could be obtained as she was brought to the hospital unconscious and died in diabetic coma. Her husband was either unable or unwilling to give any information.

For some years the patient had earned more or less of a living by selling pencils, etc., on the public streets.

After admission to the hospital radiograms of both upper extremities were taken and also some photographs. A study of the illustrations will show the peculiar conditions that were found. Inasmuch as a comparatively well formed humerus is present on both sides the case is not one of true phocomelus. On the right side three distinct phalanges can be noted in the one comparatively normal finger. Fused to the proximal phalanx is a continuous bone representing the abnormal finger. The fused phalanx is seen to articulate with a bone that in shape and size corresponds to a metacarpal. This in turn, along with an incomplete metacarpal bone, articulates with what appears to be the lower end of the humerus, no radius or ulna being apparent. A close examination of the illustration will show that this articulating surface is not in the same plane as the lower end of the shaft. When the radiograph of the opposite extremity is seen, the anatomical arrangement becomes apparent. The lower portion of the femur has bent at right angles to the shaft.

On the left side the same arrangement of phalanges and metacarpal can be seen. In this radiograph but one metacarpal can be seen, and it suggests that a fracture has occurred. As at the time the patient came to the hospital, she had a fractured femur, the result of an injury some weeks previously, it may be that the left metacarpal bone had been fractured at the same time. The left humerus shows very plainly the right angle which the lower portion has formed. There is however, a distinct break in continuity and an outer segment of bone shows distinctly. The question arises as to whether or not this represents an abortive wrist joint or is the result of an incomplete ossification at that situation.

On the right side no similar line can be seen but its absence may be due possibly to the angle at which the radiograph was taken.

The illustrations show, however, that on neither side is any

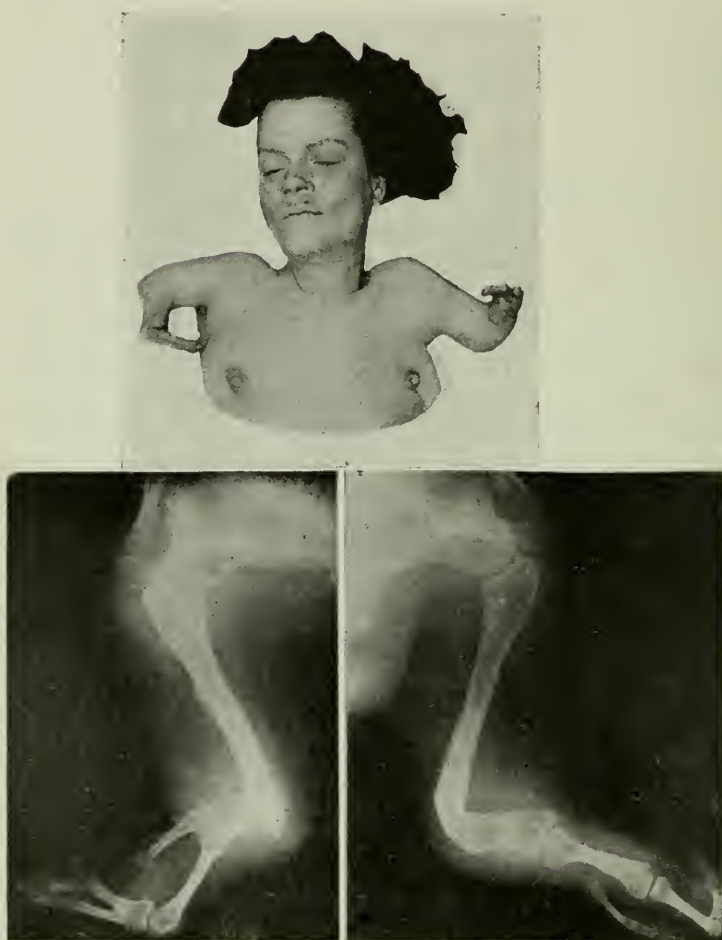


FIG. I.—Case of *Phocomelus*. GUTHRIE McCONNELL, Cleveland.
FIGS. II. and III.—Radiographs of Arm, Forearm and Hand.

trace of radius or ulna. The angulation of the lower ends of the humeri probably resulted from the early efforts in using the rudimentary hands. The constant attempts to bring the fingers to the face must have caused the bones to slowly bend until a certain amount of free movement was obtained.

It is interesting to note that no other abnormalities of development were noticed. There was, however, a distinct lateral scoliosis with the convexity to the right.

An autopsy was performed and the pathological diagnoses, based on both the gross and microscopic examinations, were as follows:

Interstitial pancreatitis. Fibrous miliary tuberculosis of the lungs plus anthracosis. Chronic parenchymatous nephritis. Degeneration of medullary portion of adrenals. The brain showed slightly thickened meninges, but was otherwise negative.

“SYMPUS APUS” WITH SPECIMEN*

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Assistant Pathologist, General Hospital, Colombo

This still-born monster was delivered at the lying-in-home at 8.10 p.m. on January 25th, 1919, and sent on to the pathological museum of the Ceylon Medical College, for preservation.

Sympus may be defined as a monster in which the lower limbs are fused together, to a greater or less degree, and with an imperfect development of them and of the neighbouring pelvic organs and pelvis.

Synonyms “sirenomelus” and “symelus.” The terms “mermaid foetus” and “foetus with a tailed appendage” have also been employed. None of these terms is quite so good as “sympus” which indicates the fusion of the lower limbs as the essential feature of the anomaly; symelus, for instance, simply means a monster in which the limbs, upper or lower are fused. To adopt the terms sirenomelus” or “syreniform foetus” is to liken the monstrosity to a fabulous creature (the siren) and is scarcely scientific. “Sympus” is, therefore, the most appropriate name.

CLASSIFICATION

1. According to Geoffroy Saint-Hilaire, this monster belongs

*This, and the succeeding article, were sent to us for publication by the author at the suggestion of Sir William Osler.



SYMPUS APUS showing Single (Fused) Lower Extremity in Stillborn Monster.

(a) Photograph of anterior view. Note complete absence of External Genitalia.

(b) Photograph of posterior view showing Anal Opening.

(c) Skiagraph showing Single (Fused) Long Bones in Thigh, and Single Bone tapering below in Leg, and complete absence of Bones of Feet.

From a specimen in the Pathological Museum of the Ceylon Medical College. Illustrations presented by S. CHELLIAH, M.B. and C.M., Madras, India.

to the class "single monsters" to the order "autosites," to the family "teratomelians" and to the genus "symelians."

2. According to Forster, this belongs to the class "sympus apus" in which the fused lower limbs end simply in a tapering point (as in this case) or in a stump like that seen after an amputation.

Obstetric History.—In this case pregnancy seemed to have terminated prematurely, the foetal movements were sluggish, and towards the end of pregnancy not felt at all. Liquor amnii was small in quantity. The labours are, in these cases often easy, delay, when it does occur, is commonly due to an associated malformation, for instance hydrocephalus or to a malpresentation. When the fused lower limbs presented, as they sometimes did, the diagnosis of presentation was thrown into doubt.

Clinical History.—None of the recorded infants survived birth for more than a few minutes, or at most hours; this is not surprising when we consider the abnormal conditions discovered by dissection. But Cichorius has recorded an interesting case of siren formation, the child living for a week after birth—in Leipzig clinic.

The morbid anatomy is a somewhat complicated subject.

1. External appearances.

The fused lower limb is usually directly continuous (as in this case) with the lower (sub-umbilical) part of the trunk and it is flattened anteriorly and curved posteriorly. It is capable of being folded upwards upon the anterior surface of the trunk; in one of the recorded cases the fused foot lay over the right shoulder and near the right ear. The lower part of the abdomen shows a tendency to narrow as it approaches the lower limb and this tendency, along with the form of the fused limb gives to the foetus its "cuspidate appearance," *i.e.*, ending in a point. There is no trace of external genitalia. Posteriorly there is a linear depression with radiating furrows which possibly indicates a rudimentary anal aperture. The body of this monster above the umbilicus is normal.

2. The conditions discovered by dissection are interesting. The sacral and coccygeal vertebrae are less in number and the sacrum, as a whole, is tilted upwards, the ilia are spread out laterally, so that the anterior superior spines are directed to the sides and downwards, their fossae are flattened. The tuberosities of the ischia are turned inwards and their ascending rami are joined in a horizontal plane with disappearance of the obturator foramina. In front of the ischia there is a projecting crest, formed by the horizontal rami of the pubic bones. The ischial and pubic bones unite to form a mass which blocks the outlet of the pelvis and shows

a wide cotyloid cavity for the reception of the large head of the fused femora.

It is on account of these conditions that Taruffi places "sympus" among the pelvic monstrosities ("lecano-terata"). A careful study of the lower limb after dissection shows the following:

The femora are completely fused with a single large head fitting into a single cotyloid cavity with two condyles articulating with a single tibia and no fibula.

The evidence of two bones in the thigh is well shown by the two nutrient foramina (seen in the skiagram) which are present on the posterior aspect of the femora, which are rotated in such a manner as to bring the external surfaces internal, and posterior surfaces anterior and the knee flexes anteriorly. There is no foot at all.

Pelvic organs are absent, viz.:

The kidneys, ureters, bladder, and the genital organs, except the right supra-renal capsule which is present. The rectum and the vermiform appendix are also absent, the descending colon ending blindly. The urachus is wanting. The umbilical cord has only one artery and one vein.

Putting all these facts together we may come to the conclusion that in "sympus" the derivatives of the allantois (urachus and part of bladder) and its vessels (umbilical arteries and vein) are usually absent and that the vessels of the cord are omphalomesenteric or vitelline in origin. Sympodia is relatively rare, only 116 instances were gathered together up to 1897. This variety—sympus apus—is rarer still. The teratogenesis is a subject which has been fruitful in ingenious explanations and yet cannot be regarded as in any degree settled. There is no explanation offered for the extraordinary rarity, the almost complete absence, of any cases of sympodia in the lower animals.

¹ Ballantyne. Ante-natal Pathology and Hygiene, the Embryo.

² Birnbaum and Blacker. Malformations of the Fœtus.

NOTES ON A CASE OF "HYPOSPADIAS PERINEALIS"

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Assistant Pathologist, General Hospital, Colombo

This patient, who will be shown presently to have had the anatomical characteristics of a man, was brought up as a woman, known by a feminine name, Punchi Nona, lived to the age of 50,

admitted into the *female* diarrhœa ward of the General Hospital, Colombo, on November 24th, 1919, with anæmia, œdema of legs and breathlessness of 6 months' duration, and died on December 1st, 1919, of uræmia due to chronic parenchymatous nephritis.

General Appearance.—Big build, large head, broad face, heavy limbs, broad shoulders, slight growth of hair on the chin and over the upper lip, larger growths in the arm-pits, slightly prominent *pomum Adami*, small conical nipples, pyramidal growth of hair over the pubis, and deep and manly voice.

External Genitalia.—(a) The penis is small, imperfectly developed, looking not unlike a hypertrophied clitoris (penis clitoridien), adherent on either side to the scrotal integument, with no meatus urinarius.

(b) The scrotum is cleft, looking like the labia majora, the right half contains a testis, the left half is empty, the other testis was found in the left inguinal canal, together with a semi-solid blue mass close to it, of the shape and size of the testis due to phlebectasis of the veins of the pampini-form plexus. This mass was punctured by accident.

(c) The urethra. The lower wall of the urethra is defective, as far back as the perineum, which condition with the cleft scrotum, looks like the vulva. The sinus uro-genitalis, thus presented, is wide and deep, about an inch in length, and opens directly into the bladder. The patient used to micturate in the squatting position.

Post-mortem Examination.—The only pelvic organ was the bladder, the wall of which was thick, the mucous membrane of slate colour and thrown into folds, due to repeated attacks of cystitis.

The pelvis. The bones heavy, axes of the ilia oblique, iliac fossae deep, inlet heart shaped, symphysis pubis deep, pubic arch narrow and pointed—characteristics of male pelvis.

Microscopical Examination.—The genital glands show the structure of the testis.

Social Condition.—The subject was not married, but lived with and was supported by his sister's son.

Synonyms.—Hypospadia perinealis, hypospadia perineo-scrotalis, pseudo-hermaphroditus externus, pseudo-hermaphroditus masculinus externus.

Statistics.—In 910 cases of pseudo-hermaphroditism collected by Neugebauer, there were 722 of the masculine variety, and only 188 of the feminine variety; and 613 of the whole series were examples of pseudo-hermaphroditismus masculinus externus.

Legal Rights.—As very many of these cases, like the one

cited above, are in reality of the male sex, doubtful cases should be brought up as boys. In three-quarters of the cases, the decision come to will prove to be correct and the inconveniences which may result, if a mistake has been made, are much less in the case of a supposed boy than a supposed girl. It had happened that a hermaphrodite of male sex had been rightly certified, soon after birth, as a boy, after a short time, on the erroneous diagnosis of a doctor, had been corrected in the registry of births as a girl; and finally, on the decision of higher authorities with much trouble had attained his proper civil rights. It is a well-known fact that the correction of a mistake in the register of births causes a great deal of trouble.

Tuffier and Lapointe are of opinion that in doubtful cases an incision is justifiable to determine the nature of the sexual gland, especially when it is situated in the inguinal region; and indeed they would go further and suggest, in view of the grave inconveniences that a wrong decision may cause, that an abdominal section for diagnostic purposes is even justifiable.

When a medical man discovers, in the course of an examination or an operation, that an individual is not of the sex in which he had been brought up, and is at the time assuming, the question as to whether he should divulge his knowledge or not is one of considerable difficulty. It must be remembered that many of the individuals are quite happy in their ignorance, and the grave inconveniences which may follow a change of sex on the part of an adult must be remembered. In cases where marriage is contemplated and the medical man is consulted on a question of doubtful sex, an operation may certainly be recommended, if necessary, to determine the point.

Clinical Significance.—It is very likely that the chronic parenchymatous nephritis, of which this patient died, is of consecutive type, due to an ascending infection, although the commonest form is suppurative nephritis or pyelo-nephritis.

A CASE OF PARASITIC THORACOPAGUS WITH
CARDIAC ANOMALY IN THE HOST: TRANS-
POSITION OF THE ARTERIAL TRUNKS WITH
PATENT DUCTUS ARTERIOSUS AND COMPLETE
DEFECT OF INTERVENTRICULAR SEPTUM
(COR TRILOCULARE BIATRIATUM)*

WALTER F. WATTON, *Brooklyn, N.Y.*

and

MAUDE E. ABBOTT, *Montreal, Que.*

The remarkable monstrosity which forms the subject of this communication occurred in a child in the practice of Dr. G. A. Campbell, of Brooklyn, N.Y., who came under the care of one of us (W. F. W.) during the temporary absence of Dr. Campbell from the city. The present communication is made with especial reference to the interesting associated cardiac anomalies in the host, on account of which the case was referred to one of us (M. E. A.) by the pathologist who did the autopsy, Dr. Archibald Murray, of the Hoagland Laboratory, Brooklyn. We are much indebted, both to Dr. Campbell and to Dr. Archibald Murray, for the privilege of the observation and for permission to report it here.

HISTORY OF THE CASE

Clinical Notes (W. F. W.) The child was first seen in June, 1920. It was then nine months old. There was a history of normal delivery by midwife. No placental examination. No history of dystocia. The baby was not sick, but the writer was called to see the case because it did not gain.

A description of the monstrosity is given below.

The baby was regular in her habits, but from the parasite there was a constant dribbling of urine so that the abdomen of the baby was quite inflamed and excoriated.

The baby was apparently mentally bright. It sat erect and supported a part of the weight of the parasite with its hands. It was pale and lips very cyanosed. There was no clubbing of the fingers. Heart: apex beat in 5th intercostal space $4\frac{1}{2}$ cm. from mid-sternal line. There was a palpable thrill over the entire precordium. Murmurs were heard over the entire precordium and could not be classified.

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

The child would cry when the skin of the parasite was pinched. The lower limbs of the parasite were semi-flexed but moved about incoordinately.

Baby gained in weight until fourteen months old, when it developed a throat infection and otitis-media. At the end of three days it was very much improved. Two weeks later it developed broncho-pneumonia and died on the second day.

Post Mortem: At the autopsy the abdominal viscera of the autosite were examined without removal from the body and retained *in situ* with their attachment to the parasite for preservation as a museum specimen. The thoracic viscera were removed intact and kept for special examination and dissection. This was carried out by one of us (M. E. A.) in Dr. Murray's laboratory on January 1st, 1921, when the following notes were made:

I. THE CARDIAC ANOMALY IN THE HOST

Description of Specimen: The specimen consists of the heart and great vessels attached to the very voluminous lungs removed from a somewhat cyanotic but otherwise apparently normal girl infant aged 14 months, which bore, protruding from the abdomen what appears to be the lower part of the body of a second female child.

The heart of the host is, relatively to the age of the child, of very large size. Its heavy ventricular portion is transversely placed to the long axis of the body, the auriculo-ventricular groove is very deep and the auricles, which are large and thick-walled, are displaced backwards so that they lie behind the upper part of the ventricles; the right auricular appendage is large and projects forward on the right side of the upper part of the ventricles to the right of the great trunks. The left auricular appendage is much smaller and is not seen anteriorly, although it curves forward also, to the left of the great trunks. These present a wholly anomalous appearance. The aorta, a relatively small, thin-walled vessel, arises transposed from the conus of the right ventricle, which forms a blunt, rounded shoulder, in the position normally occupied by the pulmonary artery and slightly to the left of the median line. It passes upward and curves to the left, gives off the innominate, left carotid and subclavian in their normal positions, and then turns downward on the left side to form the descending thoracic and abdominal aorta. The pulmonary artery is enormously increased both in the size of its lumen and in the thickness of its wall. It forms a thick, short trunk 6.5 cm. in circumference, which divides about 2 cm. above the heart into two

huge trunks which pass into the hilum of either lung, where they break up into thick-walled branches of remarkable size, which end in a network of coarse terminal branches. The lung tissue is firmly adherent to the walls of the terminal branches by fine radicles. A wide orifice, the remains of a large patent ductus, is seen in the wall of the aorta opposite the left subelavian and in the pulmonary artery at its bifurcation. This is no longer a canal but has been taken up into the wall of the two vessels which are here adherent, and only the orifice remained.

The lungs are relatively very large and voluminous and present patches of broncho-pneumonia and areas of emphysema. The pulmonary veins at the hilum are enormously dilated and the muscular layer is developed in their coats at their entrance to the left auricle. They are three, one on the right and two on the left side.

Interior of the Heart: The ventricular portion was laid open first. It showed an entire absence of the interventricular septum, the only trace of a division between the ventricles being a short muscular cushion which projects downward from above between the orifices of the two great arterial trunks. These lay above and anteriorly to the venous ostia, which were seen also opening on either side into the common chamber. The aorta, relatively small and thin-walled, rose from the extreme front of the upper left angle of the ventricle in the position normally occupied by the pulmonary artery. It is provided with three normal valves, behind the right and left posterior of which the coronaries arise. That part of the conus of the right ventricle from which it emerges is differentiated anteriorly into a small separate chamber the size of an almond by a muscular ridge with concave free edge which is continuous posteriorly with a ridge emerging with the muscular lower border of the aortic septum. The pulmonary orifice enters the upper part of the common ventricle to the right of and behind the aortic, from which it is effectually separated by the thick muscular cushion aforesaid; it is also screened from the tricuspid orifice by the large main portion of the infundibular cusp of the tricuspid valve, and from the mitral by the aortic segment of the latter. It is larger than the aortic and leads into the greatly dilated pulmonary artery.

The two venous ostia lie on either side of the common ventricle below and posteriorly. The tricuspid is relatively large, admitting two fingers, the mitral is smaller and is obliquely placed on the left side on a plane distinctly anterior to that occupied by the tricuspid. The latter has three distinct segments; of these, its marginal cusp is somewhat rudimentary, with short chordæ and

looks towards the cavity of the right auricle; its septal cusp is also short and small and is anchored by small chordæ to two papillary muscles which spring from a shallow projection from the posterior inferior wall of the common ventricle, which evidently represents the rudimentary posterior limb of the defective interventricular septum. The origin of the papillary muscle from this projection is continuous with an interlacing network of columnæ carnæ that extends over the anterior inferior ventricular wall, projecting into the periphery of the cavity and resembling the spongy musculature of the embryonic heart. The infundibular tricuspid segment is of great size, and screens by its main portion the orifice of the pulmonary artery from the right auriculo-ventricular orifice. It passes obliquely forward upward and to the right from the left side posteriorly; its outer edges are well developed and are attached to the papillary muscles by well developed chordæ; its central part, however, is not free but is constricted and attached to the strong muscular pillar between the mouths of the aorta and pulmonary artery, while just beyond its centre a few short chordæ are seen which are attached to this same muscular bundle. The smaller part of this infundibular cusp shields the aortic orifice from the tricuspid. The mitral valve has two cusps; a left anterior and right posterior. The latter is directly continuous in its posterior part with the infundibular cusp of the tricuspid, its chordæ tendineæ meeting those of the latter cusp at an acute angle and springing with them from an independent bundle of papillary muscles arising upon the left posterior wall of the ventricle. The anterior mitral segment is thick and short, with normal attachments.

The auricles are both hypertrophied and dilated, the dilatation being the most marked in the right auricle, while the left auricle is greatly hypertrophied, its wall being in some places 3 to 4 mm. thick, and lined with a greatly thickened endocardium. *The auricular septum is entire, the foramen ovale completely closed, and is very thick and strong.* The orifice of the inferior cava is enlarged to about three times its size. The Eustachian valve is a thick, muscular ridge. The Thebesian valve is also represented by a muscular structure and the muscoli pectinati of the right appendix are markedly developed. The left auricle is a strong unwieldy structure and presents three huge openings into the large channels of the pulmonary veins, which lead respectively one to the left and the other two to the right lung. These organs contain numbers of large thin-walled veins which form large venous sinuses, many of which lie superficially directly under the pleura.

Course of the Blood: The relative position of the arterial and

venous ostia and the relation of the contiguous part of the anterior mitral and the infundibular tricuspid segments and the muscular ridge separating the two arterial ostia to these and to each other, seems to supply a compensatory arrangement that would have permitted a considerable proportion of the aerated blood from the left auricle to pass into the aorta in spite of its origin from the right side of the common ventricle. Thus, the tricuspid is placed behind and to the right and directed from the right anteriorly to the left posteriorly, while the pulmonary orifice lies above and anterior to it, but on a plane behind the aortic orifice and shielded from the mitral orifice by the anterior mitral segment; and the mitral orifice is also placed obliquely, passing from the right anteriorly to the left posteriorly, and looks towards the aortic orifice, and is in front of the pulmonary and shielded from it by its anterior segment, but is on the same plane with the aortic orifice, which is in turn guarded from the orifices behind it by the aortic septum. The current of venous blood would, therefore, seem to have passed from the right auricle through the tricuspid first into the pulmonary artery, as this lies in juxtaposition in the common ventricle, and then, auricular contraction following an instant later in the left auricle, the aerated blood would have been sent thence through the mitral orifice chiefly into the aorta. This mechanism is seen also in the three-chambered heart of the turtle.

Anatomical Diagnosis of Cardiac Anomaly in Host: Complete transposition of aorta and pulmonary artery, aorta from right ventricle to the left and anteriorly, pulmonary from left ventricle to the right and posteriorly; complete absence of interventricular septum (cor-biatriatum trilocular; anomalous formation of tricuspid segments with compensatory hyperplasia of infundibular cusp; hypoplasia of aorta; great dilatation of pulmonary orifice and artery and branches and of pulmonary venules and veins; auricular septum closed; marked dilatation of both auricles but especially the right; hypertrophy of both auricles, but especially the left; hypertrophy and dilatation of common ventricle; large patent lumen of ductus arteriosus (direct communication.)

REMARKS ON THE CARDIAC ANOMALY

The interest of this case from the congenital cardiac standpoint is threefold. First, the combination itself of a grave cardiac anomaly in the host of a double monster of the parasitic type, is not only unusual, but is, so far as we know, unique in the literature. The rarity of such an occurrence is readily explained by a review of the ontogenesis of the monstrosity. Reflection shows us that

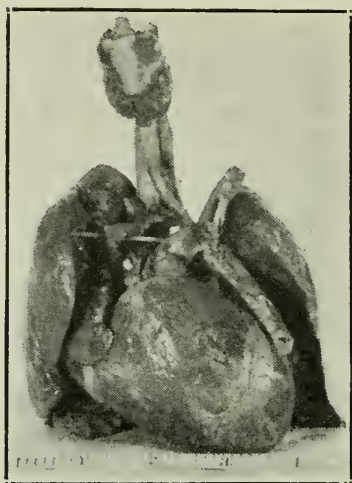


FIG. III.—CARDIAC ANOMALY IN PARASITIC THORACOPAGUS

Exterior view of the Heart and great Vessels, of the Autosite, showing the transposed aorta of large size and arising anteriorly and to the left in the position normally occupied by the pulmonary artery. The lungs are very voluminous.—W. F. WATTON and M. E. ABBOTT.

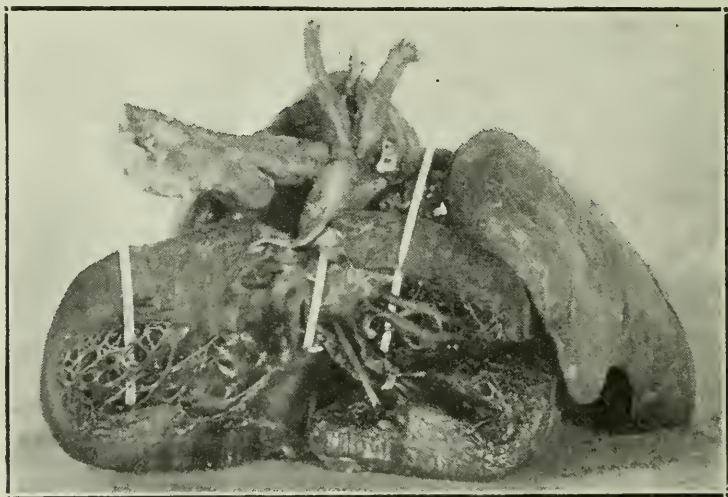


FIG. IV.—Heart of Autosite laid open to show the orifices of the transposed vessels, that of the aorta lying anteriorly, and that of the pulmonary artery lying posteriorly, in the position normally occupied by each other and separated by a thick muscular cushion. Interventricular septum completely absent. Musculature of Columnae carnae heavily developed. W. F. WATTON and M. E. ABBOTT.

in a thoracopagus or any other form of double monster, we are dealing with what was originally a homologous twin pregnancy, in which the two germinal areas were implanted too close to each other (at a distance of less than 180°) on the surface of the blastomere, so that fusion has resulted, leading, in the case of thoracopagi, to attachment of the two fetuses along the median line of the thoraco-abdominal wall; and that, in the parasitic or asymmetrical form of such a double monster some unexplained agency has acted, subsequently to the event of fusion, adversely upon one member of the group, so that its circulation has become depressed or overpowered, and a suppressed parasitic individual has resulted, which is attached to or included in the body of the larger individual, and is of smaller size, with certain members or parts of members missing, rudimentary or deformed, and with heart frequently rudimentary or absent (as in the variety known as *Dipygus Parasiticus* here reported). But homologous twins are in their origin essentially normal individuals (Stockard¹), and so also, as a necessary corollary, are symmetrical double monsters of the thoracopagus type. It follows that in the asymmetrical or parasitic form of thoracopagus the larger member of the pair, that is the autosite, whose circulation has not been interfered with, remains as a rule unaltered, and attains maturity as an individual with *perfectly developed heart* and normal in all respects, except that it supports the imperfect body and members or parts of members of the parasitic twin. In the present case, however, we have, in the heart of its host one of the severest forms of congenital cardiac disease that is consistent with life.

Secondly, the primary cardiac anomaly that exists here (complete transposition of the great trunks) is of such a nature as to invite speculation as to a possible causal connection with the same factors as led to the origin of the monstrosity. Transposition of the arterial trunks has a different etiological basis from that of a transposition of the viscera; nevertheless, since a reversal of the normal torsion of the ventricular bend of the embryonic heart is known to be a factor in their altered relations (Keith, Lewis²), the question arises: Did the phenomena that underlay its occurrence in the heart of the host in the present case bear some obscure relation to mirror-picture transposition of the viscera (*situs inversus*), of the normal twin such as is known to occur so frequently

¹Stockard, C. R., Development Rate and Structural Expression: An Experimental Study of Twins, 'Double Monsters' and Single Deformities Etc. *Amer. Jour. of Anat.*, 1921, xxviii, 115.

²Lewis and Abbott. *Anat. Rec.*, 1915, ix, No. 1. Also this Bulletin, 1916, vi.

in one of the members of a symmetrical double monster of the thoracopagus type?

Thirdly, the cardiac condition in the host is *per se* of exceptional interest. Complete transposition of the great trunks is in itself of infrequent occurrence; but cases such as this, that survive the first few weeks of infant life and that present only a *moderate* degree of cyanosis are extremely rare, for complete transposition is one of the chief causes of deep cyanoses from birth, the so-called morbus cœruleus, with early fatal termination. The explanation of the more favourable features in the present case is to be found in the remarkable adaptations of structure that exist here, whereby the difficult conditions of the circulation imposed by the origin of the aorta from the right ventricle are met in what would appear to be the best manner possible. These adaptations consist in: (a) a complete absence of the interventricular septum, with a peculiar juxtaposition of the arterial and venous ostia respectively (the latter condition resembling the arrangement in the heart of a turtle); and (b) a widely patent ductus arteriosus. The pulmonary artery is widely dilated and the foramen ovale is here completely closed. Of these anatomical features, the most important is the absence of the septum, for the triloculate heart resulting therefrom allowed free passages of the arterial and venous currents to their respective destinations through the common ventricle.

The literature on complete transposition of the arterial trunks bears out the conclusion which is suggested by the examination of this specimen, namely, that absence of the interventricular septum together with patency of *one* or other of the foetal passages, foramen ovale or ductus arteriosus, is that adaptation of structure which best meets the need of the circulation for aeration under the altered conditions imposed by the transposed trunks. Practically all the cases terminating in the first weeks or months of life and deeply cyanotic from birth or shortly thereafter, have a closed interventricular septum; and, on the other hand, the few cases who reached adult life or showed late or moderate cyanosis had a ventricular septum that was either absent or largely defective. Thus, in Keith's³ case, who lived to the age of 16 years, there was a large defect of the septum, with patent foramen ovale. In Elliott's⁴, who lived to 19 years and nine months, the septum was absent and the foramen ovale admitted a goose quill. In Guttman's, dying at two

³Keith, *Jour. Anat. and Phys.*, xlv, 1912, case V, p. 17.

⁴Elliott, *Jour. Anat. and Phys.*, 1877, xi, 302.

years, cyanosis was first noticed at the end of the 6th month and was moderate in degree; the upper two-thirds of the ventricle septum was absent and the ductus patent, the foramen ovale closed.

II. THE MONSTROSITY

Inspection of the monster showed this to be surmounted above by a triangular appendage with base upward which consisted of the rudimentary shoulder girdle and fused upper extremities curved inward below and attached by a constricted bridge of fleshy tissue over which the body skin is continuous to the lower part of the trunk and the fully developed hips, buttocks and lower extremities of the parasitic twin. The abdominal wall is absent, and a mass of rudimentary intestine is exposed (Fig. II). The trunk is surmounted by normal female genitalia. The kidneys were present and urine was passed occasionally, but there was no anus and the intestines did not functionate. The ventral surface of the parasite is apposed to that of the autosite, to which it is attached by skin and fascia at two places: (a) at the umbilicus where the large umbilical vein passes from the parasite into the liver of the host, where it empties into the hepatic veins, which thus transmit the blood from the parasite to the right heart of the autosite; (b) at the lower border of the thorax, left side, where two small arterioles were demonstrated, passing from the host to the parasite. Careful dissection showed these vessels to constitute its entire blood supply.

Anatomical Diagnosis of Monstrosity: Asymmetrical thoracopagus; acardiac and acephalic monster having rudimentary and fully developed lower extremities, gastro-schisis, and rudimentary alimentary tract; umbilical and supra-umbilical attachment to autosite. Type known as Dipygus Parasiticus.

REMARKS ON THE MONSTROSITY

Parasitic Thoracopagus, although of rare occurrence, is well recognized in the annals of medicine, for the reason that its subjects are viable and present an extraordinary and grotesque appearance which, in adults, has always attracted public attention and record. The condition is sufficiently rare to excite surprise and curiosity and most of the cases have been exhibited as museum freaks. Probably the most famous case is that of the Italian Colloredo, born in Genoa in 1642, who bore, attached to the ensiform cartilage, the head, thorax, the two upper and one lower extremities of a second individual. The parasite neither ingested



FIG. I.—PARASITIC THORACOPAGUS WITH CARDIAC ANOMALY IN HOST.

Moderately cyanotic female child, aged 14 months, bearing attached to its abdomen in the median line the perfectly formed lower extremities and rudimentary upper extremities of a parasite twin.—W. F. WATTON and M. E. ABBOTT.

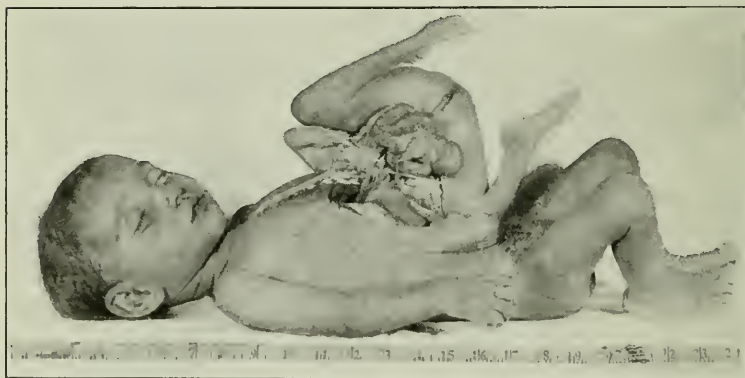


FIG. II.—The parasite everted, to show its attachment to the Autosite at two points (*a*) the umbilicus, (*b*) the lower margin of the left wall of the thorax. The abdominal wall of the monster is widely cleft and its intestines are exposed extruded.—W. F. WATTON and M. E. ABBOTT.

nor excreted anything but saliva and the eyes were always closed. A similar but more rudimentary case consisting of a head and thorax is republished by Fingland from the *Gentlemen's Magazine*, of 1777; the man was one James Poro, born in Genoa in 1686. The head of a small second individual projected upward from the centre of his chest and wears a becoming hat.

Hirst and Piersol state that the type of monster varies according to the point of attachment to the host, in that the higher up the attachment is in the long axis of the body of the host the greater the tendency will be to the development of the head end of the parasite. This contention is well supported by these two cases above cited where the head was developed and the lower extremities suppressed, for in both cases the attachment was to the thorax and not to the abdomen of the autosite. It is also strikingly borne out by the cases of *Dipygus Parasiticus* in the literature, of which the case reported here is an excellent example. Both in this and in the practically identical cases reported by Schwalbe⁵ and Lindley Mills⁶, the attachment is to the upper abdomen (umbilical and supra-umbilical), and in all the parasite is an acephalic and acardiac monster, with rudimentary upper and fully developed lower extremities. In the celebrated Indian boy, Laloo, who is the best known example of *Dipygus Parasiticus*, the upper extremities were well developed also. He lived to be 32 years old, and was exhibited in London at the age of seventeen. A complete study of him as a living case was presented at that time by Drs. Bland Sutton and S. G. Shattock before the Pathological Society of London, and was published in their *Transactions*². The illustration shows him to have been a lad of handsome and engaging countenance and of normal appearance except that there was attached to the abdomen in the median line, an acephalic trunk with four normal extremities. The arms were long and usually held encircling the neck. The intestines were rudimentary and did not functionate, but the urinary organs did. The attachment was at two points: (a) to the thorax at the ensiform cartilage, (explaining the high development of the arms); and (b) to the abdomen at the level of the umbilicus by a pedicle 13 cm. long which contained intestines.

Additional confirmation upon the influence of the point of attachment on the parts developed or suppressed in the parasite is given by two well known cases of infra-umbilical attachment. In one of these, John Baptista dos Santos, born in 1845, a super-

⁵Langley Mills, *B. Med. Jour.*, 1888, II, 233.

⁶Sutton and Shattock, Report on a Living Specimen of Parasitic Fœtus (Laloo). *Trans. Path. Soc. Lond.*, 1888, xxxix, 427.

numery lower extremity grew from the pubis, and in the other, Louise L., born in 1869, and known as "*La Dame a Quatre Jambes*" (cited by Fingland), a rudimentary pelvis and two atrophied legs were attached to the pubis by a bony pedicle.

SUMMARY AND CONCLUSIONS

1. A case of asymmetrical thoracopagus is recorded of the type *Dipygus Parasiticus*, in which the parasite has an umbilical and supra-umbilical attachment and consists of the rudimentary upper and complete lower extremities of the second foetus. The case belongs in the same class with Laloo and those reported by Schwalbe⁷ and Mills.

2. The parts of the parasite to be developed or suppressed vary directly with the point of its attachment to the thoracic abdominal wall of the autosite, as contended by Hirst and Piersol. The case reported here presents an additional verification.

3. The autosite was cyanotic and the subject had a grave cardiac anomaly, thus presenting an exception to the rule that the heart of the autosite in this form of monstrosity is usually normal.

4. The primary defect in the cardiac anomaly complex is transposition of the great trunks. The other defects are secondary and compensatory in character to facilitate the aeration of the blood. Of such structural adaptations the most important, in transposition of the great trunks, is defect of the interventricular septum, and only cases presenting that combination attain adult life.

The thanks of the writers are due to Dr. G. S. Huntington for verification of the pathological findings in the specimen here recorded.

⁷Schwalbe, *Morphologie Der Missbildungen*, Part II, pp. 346-347, Jena, 1907.

CARDIAC ANOMALIES

ANOMALY OF HEART AND AORTA; MULTIPLE
DEFECTS WITH STENOSIS OF AORTIC ARCH
AND PULMONARY ARTERY BECOMING
DESCENDING AORTA

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Anomalies of the heart are of relatively common occurrence, but certain types of defect which are less frequently seen are of particular interest by reason of the special anatomical and physiological problems which they present. To this class, we believe, belongs the so-called infantile type of aortic stenosis with the pulmonary artery becoming the descending aorta through the persistence and dilatation of the ductus arteriosus.

The case herewith reported showing this anomaly, has an added interest in the presence of a group of associated anomalies, one of which, a patent urachus, was indirectly responsible for the death of the child in that it served as the portal of entry of an infection which spread to the bladder and kidneys and terminated in a septicemia.

CLINICAL HISTORY

The mother entered the New Haven Hospital on December 3rd, 1920, and, following a labour of $6\frac{1}{2}$ hours duration, at the very onset of which the membranes had ruptured, gave birth to a male child weighing 3.45 grams.

She had had one previous normal pregnancy and no miscarriages. Physical examination during present pregnancy showed the pelvis to be normal. The Wassermann was negative.

The child was feeble from birth and immediately lost weight much more rapidly than is normal (400 grams in the first six days). The breathing was shallow and there was difficulty in swallowing water and milk. A supernumerary finger on the left hand and an extra toe on the right foot were noted. The baby was transferred to the pediatric service on the 14th day on account of signs of urinary infection and the following notes were made:

Physical Examination. The skin is slightly yellow with varying degrees of cyanosis and lividity. There are dilated veins in the anterior abdominal wall leading upward from the umbilicus.

The umbilical stump, covered by a crust, appears infected. The breathing is uneven, at times is extremely rapid, during which periods the child becomes pale and livid, but when crying face, hands, and feet become blue. Over the left chest there is dullness continuous with that of the heart and limited by clavicle, posterior axillary line, and 4th rib. Breathing on the left side is tubular in type. A loud systolic murmur is everywhere audible over the left chest but is heard best along the left sternal margin in the 2nd and 3rd interspaces. There is a gallop rhythm of the heart. A mass is felt in each flank interpreted as enlarged kidneys. A bilateral dislocation of the hip is noted.

Laboratory Findings. Blood:—red blood cells, 6,576,000; hæmoglobin, 75%; white blood cells, 32,000. Urine:—trace of albumin, many red blood cells, pus cells, and bacteria. X-ray showed a large shadow in the chest interpreted as an enlarged heart. Blood cultures taken on the 12th and 13th days each showed *B. coli* in pure culture.

Course in Hospital. The patient never regained lost weight. The masses in the flanks progressively became more easily palpable. With the exception of the appearance of jaundice on the 18th day after birth, there was little change in the gross physical findings. The patient died on the 20th day, apparently from a severe infection of the urinary tract.

Clinical Impression. (1) Congenital deformities of hands and feet; (2) congenital malformation of heart; (3) atelectatic lung (left); (4) bilateral congenital dislocation of hip; (5) bilateral pyelonephritis.

AUTOPSY

Body. The body is that of a poorly nourished male infant weighing 3,075 grams. and measuring 50 cm. in length. The skin, particularly of the face, is thin and more or less wrinkled. It has everywhere a distinct yellow jaundiced tint. This is true also of the conjunctival mucosa. The head and body are in general of normal configuration but detailed examination discloses several deformities. There is a sixth digit on the left hand, a duplication of the terminal phalanx of the fifth finger to which the extra member is attached. There is a similar extra digit attached to the fifth toe of the left foot. There is slight clubbing of the feet and clinical examination revealed bilateral dislocation of the hips. Mouth and nose show nothing noteworthy. Superficial lymph nodes are not enlarged. The cranial sutures are not ossified and both fontanelles are widely open. The abdomen is not distended. A small probe can be inserted in the umbilicus for a distance of

about 1 cm. There is no discharge and no other evidence of an acute inflammatory reaction. On opening the abdominal cavity the viscera seem to lie in normal positions. The large intestines and the greater part of the small intestines are collapsed. The colon is contracted to almost a cord. The stomach is moderately distended. The liver projects several centimeters below the costal margin. About the middle of the upper surface of the right lobe there is a small knob-like prominence elevated about 15 cm. Corresponding to this a small socket is found in the diaphragm, but the latter is nowhere perforated. Mesenteric fat is very slight in amount. There are no abnormal peritoneal bands or adhesions and no superfluous fluid in the peritoneal cavity.

Since the autopsy incision is limited to a small opening in the abdominal wall, a satisfactory examination of the thoracic cavity cannot be made. The heart and lungs, however, are removed through an opening in the diaphragm. So far as can be made out there is no excess fluid in the pleural or pericardial cavities and no pleural adhesions.

Heart. The shape of the organ is quite abnormal as indicated by the following measurements: length of heart (base to apex) 4 cm.; width of heart, 6 cm. The surface is smooth with very little epicardial fat. The coronary vessels are distinctly seen. Upon opening the chambers and vessels a number of abnormalities are found: (1) a patent foramen ovale, approximately 1 by 1.5 cm.; (2) a perforated interventricular septum, opening about 3 mm. in diameter; (3) stenosis (coarctation) of the arch of the aorta; (4) patent and enlarged ductus arteriosus. Presumably as a result of these anomalies, the right side of the heart is markedly hypertrophied, forming at least two-thirds of the volume and weight of the organ. Its wall measures from 4 mm. to 12 mm. in thickness, the latter measurement being taken through a thick mass of muscle forming the base. The right auricle is dilated but its wall is not appreciably thickened. The openings of the superior and inferior venæ cavæ are normally situated. The tricuspid orifice is apparently normal in size, measuring at least 4 cm. in circumference. The anterior cusp is fairly delicate but the margins of the middle and posterior cusps show warty bulbous thickenings. These changes are most marked in the neighbourhood of the perforation in the septum which opens into the right ventricle in the angle between the middle and posterior cusps. The pulmonary veins enter the left auricle in apparently normal relations and both left auricle and left ventricle are normal looking except for the septal perforation already noted. The arterial (pulmonary) orifice of the right ventricle measures about 2.5 cm. in circumference.

The cusps are delicate. As the accompanying diagram shows, this arterial trunk (pulmonary artery) gives off just above the valve two large branches which go respectively to the right and left lungs. The main vessel is continuous with the abdominal aorta through a persistent and much dilated ductus arteriosus (Fig. 1). The aortic orifice appears to be slightly narrowed, measuring about 1.5 cm. in circumference. The cusps are three in number, not fused or sclerotic, and are apparently competent. The perforation in the interventricular septum is situated about 3 mm. below the aortic valve (Fig. 2). The coronaries are given off normally. The ascending aorta looks to be of normal size measuring 2 cm. in circumference, but with the giving off of the innominate, which appears unusually large (1.5 cm.), the arch becomes suddenly narrowed to about one-third the usual diameter. Just beyond the opening of the left subclavian artery the trunk becomes narrowed to a marked degree, so that the opening into the ductus arteriosus, which, as stated above, is continuous with the abdominal aorta, will admit only a small probe. In other words, there is a stenosis of the entire arch with extreme narrowing, almost an atresia, at the isthmus. The persistence and dilatation of the ductus and the marked hypertrophy of the right ventricle are no doubt changes secondary to this anomaly in the aorta.

Lungs. The right lung weighs 35 grams. It is moderately voluminous and generally crepitant except for the posterior portion of the middle lobe where there is a firm consolidated patch about 3 cm. in diameter extending to the surface. The pleura over this area is covered by delicate fibrinous exudate. On section the tissue here is greyish-red in colour and fairly dry. A few small patches of consolidation are found in the other parts of this lobe, but none in the other lobes. The left lung is smaller than the right and its upper lobe is thin, as though compressed by the enlarged heart. The lung is rather red but crepitant throughout. No patches of consolidation are seen or felt. The pulmonary arteries show a normal branching. The bronchial lymph nodes are not enlarged or otherwise altered.

Liver. The liver weighs 3,175 grams. It is normal in shape except for the knob-like projections on the upper posterior surface of the right lobe already described. On section the lobulation is fairly distinct. The tissue has everywhere a jaundiced hue. Examination of the bile ducts, however, shows no obstruction. A probe introduced into the ampulla of Vater passes readily into the liver and can also be inserted through the cystic duct into the gall bladder.

Gall Bladder. The sac is definitely distended. The contents consist not of true bile, but of a perfectly clear, colourless, viscid, mucoid fluid. Before opening the gall bladder this fluid could be expressed into the duodenum, although fairly strong pressure was necessary to do this. Since no obstruction of the cystic duct could be made out, it seems probable that there must have been some twist of the neck of the gall bladder or the cystic duct which prevented the inflow and outflow of bile.

Kidneys. The kidneys are both distinctly enlarged, each weighing approximately 45 grams. Fetal lobulations are quite distinct but the general contour of the organ is normal. The cortical markings are fairly clear, but there are scattered through both cortex and medulla tiny, yellowish-white foci which look like miliary abscesses. The entire organ is congested. The pelvic mucosa is deeply injected and has lost its normal smoothness. This is true to a somewhat less extent of the mucosa of the ureters. There is no dilatation of the pelves or ureters, and there are no cysts in either kidney.

Urinary bladder. The bladder is moderately contracted. The wall is thickened but the thickening involves principally the mucosa and submucosa. The mucosa everywhere except in the fundus shows coarse longitudinal folds, the crests of which are covered by greyish necrotic exudate. The fundus is less affected, being relatively pale and smooth. The urachal opening is not closed and a probe can be inserted into it for a distance of a centimeter. There seems to be a moderate dilatation of the entire fundus as well as of the urachal opening, giving the bladder cavity an oblong shape.

Other organs, including pancreas, spleen, adrenals, stomach and intestines show no abnormalities or other change.

BACTERIOLOGICAL DIAGNOSIS

From the left kidney a non-hæmolytic streptococcus and *B. coli* were obtained. The right lung shows a non-hæmolytic streptococcus, staphylococcus aureus, and *B. coli*.

ANATOMICAL DIAGNOSIS

(A) Incomplete closure of urachus; acute phlegmonous cystitis and suppurative pyelonephritis; broncho-pneumonia.

(B) Anomaly of heart and aorta; stenosis of aortic arch; patent ductus arteriosus with pulmonary artery becoming descending aorta; defect in interventricular septum; patent foramen ovale; hypertrophy of right heart (auricle and ventricle).

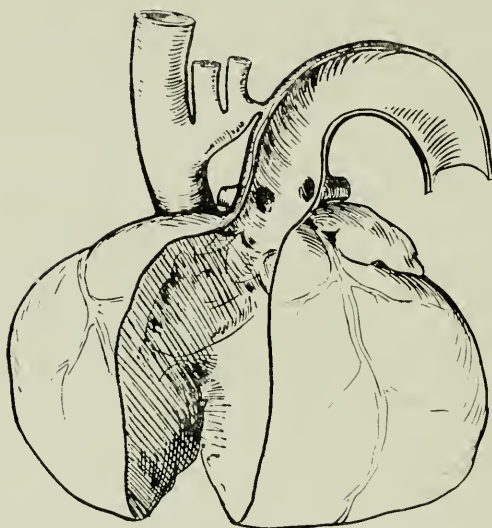


FIG. I.—Stenosis of aortic arch with pulmonary artery becoming descending aorta through dilated ductus arteriosus.

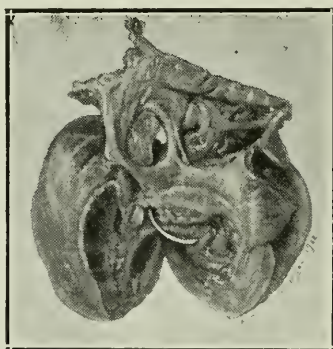


FIG. II.—Patent Foramen Ovale and Perforation of Interventricular Septum. View from left side of heart.

(C) Supernumerary finger and toes; local defect in diaphragm; congenital dislocation of hips.

DISCUSSION

Two independent sets of phenomena were present in this case, for both of which serious developmental defects were responsible, (1) ascending infection of the urinary tract, resulting from a patent urachus, and (2) circulatory disturbances associated with multiple anomalies of the heart and great vessels. The former was obviously the cause of death, but since the sequence of events is fairly obvious, discussion is unnecessary.

Of the several anomalies of the heart and arterial trunks, stenosis of the aortic arch is clearly the most important, and would no doubt have constituted a serious disability but for the persistent dilated ductus arteriosus. The hypertrophy of the right ventricle resulted no doubt from the extra work put upon this side of the heart. Since during life no difference was observed in the circulation of the upper extremities supplied by blood direct from the left ventricle and that of the lower extremities whose blood came from the right ventricle, it would appear that there was a free admixture of systemic and pulmonary blood and that the aortic defect was well compensated for by the associated anomalies, the most important of which is the dilatation of the ductus arteriosus.

Abbott (*Amer. Jour. Dis. Chil.*, 1921, 22,508) was able to collect from the literature only six cases of "pulmonary artery becoming descending aorta," and Fraser (*Proc. N. Y. Path. Soc.*, 1921, 21, 91) who adds two cases, speaks of being able to find only three or four recorded in which the aortic stenosis was as marked as in his cases. Abbott regards the persistence of the ductus and the consequent provision of a new route of blood flow from the heart to the lower extremities as a compensatory measure, "an adaptation to the needs of an obstructed or de-oxygenated circulation from the left ventricle." Certainly, but for some such process of adaptation, death would very promptly ensue.

It is noteworthy that in a majority of the reported cases, death has been referable as in the present case, either to some associated and uncompensated anomaly, or to a complicating infection, to which the "defective" child is no doubt less resistant than the normal individual.

REPORT OF A CASE OF COARCTATION OF THE
AORTA AT THE ISTHMUS WITH DILATATION
AND RUPTURE OF THE ASCENDING PORTION
OF THE ARCH*

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The case reported here is by no means unique, but it has a combination of features which places it among the rarer conditions. Numerous authors, among them Hirschfelder and Adami, merely mention the condition of stenosis at the isthmus, and dismiss it with a few words about congenital and acquired types. Delafield and Prudden mention a case which is almost similar to the one described here, but give no reference. The literature on the subject, was studied exhaustively by Dr. Maude Abbott, of McGill University, and what will undoubtedly remain as the last word on the subject for a very long while to come was written by her in her splendid chapter on "Congenital Cardiac Disease" in Osler's *System of Medicine*. The following is a brief account of the clinical history and pathological findings of the case:

Personal History: M. J., age 18 years, white, male. Robust, active and athletic young man. No previous illness. One year prior to death, when physically examined at the Y.M.C.A., he was advised to give up athletics because his heart beat too rapidly, but he did not follow the advice.

Family History: Negative.

Present Illness: Two days prior to his death, as he was leaving a street car, he felt a sudden pain and a sense of tremendous pressure within his chest, as if he "were going to burst." He became dizzy, and weak in the knees, but continued on his way. After he had gone several blocks he attempted to blow his nose, and during the act fell to the sidewalk unconscious. At the hospital he regained consciousness, and aside from a feeling of fullness in the chest, felt quite well.

Physical Examination: Sensorium clear. He was restless, anxious, and very hyperpnœic, though not conscious of shortness of breath. There was cyanosis of the pinna of the ears, of the face, of the lips, and of the entire neck in collar fashion. The pulse was not palpable in any of the accessible arteries except at

*Presented at the 13th Annual Meeting of the American and Canadian Section of this Association, New York, April 1st, 1920.

rare intervals in the left dorsalis pedis artery. Heart rate 106. Lying down, the head was intensely cyanotic and cool, with high capillary pressure. Sitting up, the head and neck were pale, with no cyanosis. Extremities, though pulseless, were warm and not cyanotic. There was moderate enlargement of the precordial area of dullness, with considerable widening of the mediastinal dullness to the right and left of the sternum. Over the aortic area there were a systolic impulse and thrill, a diastolic impact, a systolic murmur, and tympanitic aortic closure. Maximum systolic blood pressure (left dorsalis pedis) 80.

Fluoroscopic Examination: "This shows globular enlargement of the heart and a wide mediastinal shadow which pulsates not only with cardiac systole, but also moves with respiration. Cardio-hepatic angle acute."

Clinical Diagnosis: "Elongation and dilatation of the ascending, transverse, and descending aorta, with rupture of the arch."

Diary: Patient became unconscious again, and died 36 hours after admission to hospital.

Important Post Mortem Findings: The ears and lips are deeply cyanosed. Each pleural cavity contains 200 c.c. of sanguineous fluid. There is diffuse subpleural hæmorrhage over the inner part of all three lobes of the right lung. This is continuous with a subadventitial hæmorrhage of the pulmonary artery. The pericardial cavity is very markedly distended, the dilatation being most marked toward the left side with little alteration of the cardio-hepatic angle. In the region of the ascending part of the arch of the aorta there is a particularly large bulging of the pericardium, much more so than in an ordinary effusion into the pericardial cavity. The parietal pericardium has a diffuse hæmorrhage throughout its tissue, especially marked on the right side where it extends to the diaphragm. When opened, the pericardial cavity is found to contain a very large amount of blood, both fluid and clotted. But even after this blood is removed, the special bulging in the region of the ascending part of the arch remains. The outer covering of this bulging is very thin, and clotted blood can be seen and felt through it. When this is snipped, a large blood clot is disclosed to view. When the latter is removed, it is found that the outer thin covering is adventitia of the aorta which has been dissected up by hæmorrhage, and the remaining layers of the aorta are now disclosed to view. These show a linear tear through them running obliquely from 9 cms. above the aortic ring on the right side, to within 1.5 cms. of it on the left side. The intima and media are laid open very widely in two flaps, the upper one of which is bent back on itself and ad-



PLATE I.—RUPTURE OF INTIMA AND MEDIA IN DILATED ASCENDING ARCH OF AORTA.

- (a) Adventitia (dissected up by haemorrhage).
- (b) Intima and media (ruptured and laid open in two flaps).
- (c) Bicuspid aortic valve. (Congenital anomaly).
- (d) Parietal pericardium.

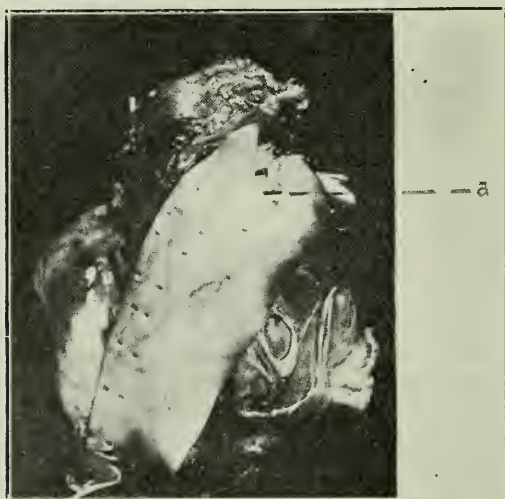


PLATE II.—COARCTATION OF AORTA AT THE ISTHMUS.

- (a) Cicatricial ridge at site of entrance of the Ductus Botalli (narrowing the lumen by 1 cm.).

herent by means of some thin, fibrinous adhesions. The lumen of the aorta is filled with clotted blood. There is a moderately large fusiform dilatation of the entire ascending part of the arch of the aorta. The ductus Botalli is closed. At the site of its entrance into the aorta there is a cicatricial ridge which has narrowed the aortic lumen by 1 cm. The entire wall of the aorta is thinner than natural, but is not thinner at site of dilatation than in the rest of the vessel. The aortic valve presents an abnormality. It has only two cusps, both of which have their origin from the left side of the aorta. Where these cusps unite laterally, they lie partly free in the aortic channel. The cusps are of uniform thickness, are soft and pliable, showing no evidence of inflammation. The remaining valves are normal. The left ventricle is moderately hypertrophied, but is not dilated. The thickness of the aorta is uniform throughout, but slightly less than natural. There is a small subintimal calcareous plaque in the ascending portion of the arch, and a few streaks of subintimal atheroma in the rest of the aorta. The wall of the aorta is very elastic. The intercostal vessels present no abnormality.

SUMMARY

1. This is evidently a case of coarctation of the aorta at the isthmus, and is of the so-called adult type.
2. It has associated with it the rather common abnormality of bicuspid aortic valve, and the less common dilatation of the first part of the arch of the aorta.
3. The entire aortic wall, though thinner than natural, is no thinner at the site of dilatation.
4. The rupture is of the dissecting type, and hæmo-pericardium, bilateral hæmo-thorax, and diffuse subpleural and sub-pericardial hæmorrhage are associated with it.
5. The presence of the aortic dilatation and rupture was diagnosed clinically.

CARDIAC DEFECTS IN THE LIGHT OF THE
COMPARATIVE ANATOMY OF THE
VERTEBRATE HEART*†

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I. INTRODUCTION

The causes of anomalies in the anatomical structure of the human frame are to be sought, in the great majority of instances, in an arrest or aberration of growth at some point in antenatal life before complete development has been attained. In the course of preparation of the fasciculus on cardiac anomalies of the catalogue of this museum, this well recognized fact suggested to us the idea that the origin of such defects would be greatly elucidated by a supplementary collection of hearts from the lower orders of the vertebrate kingdom, which should illustrate, in an orderly and conspicuous fashion, the various stages in the development of the human heart as these are mirrored in their phylogenetic prototypes. It was thought further that such a series might be of value, not only as setting forth in visible and, as it were, permanent form, the various stages through which the embryonic heart is known to have passed, but also by explaining the occurrence of certain anomalies in which growth has apparently been stopped at a point which does not correspond to any known stage of development of the human embryo. Such specimens would thus reveal conditions of a fleeting or evanescent character which might fairly be deduced to have existed in the human species for a brief period in the embryonic cycle, and to have become submerged in the further process of development, or they may indicate a harking back to some remote ancestral trait that has long since disappeared in the upward trend of evolution. For, in the words of E. Haeckel in his "Evolution of Man,"¹—"it must be accepted as a quite universal fact in phylogenetic evolution *that the parent forms themselves with their specific characters have mostly become extinct.*" From this point of view, correlation of the facts of human embryology, comparative anatomy and antenatal pathology may thus yield information of a mutually illuminating character in a field of research that is not yet widely tilled.

*Presented at the 12th Meeting of the American and Canadian Section of this Association at Atlantic City, N.J., June 14th, 1919.

†Published with the help of a grant from the Cooper Fund for Medical Research.

¹Haeckel, Ernst. *The Evolution of Man*, Vol. II, London, 1879.

Such a correlation of ontogenetic and phylogenetic objective material with anatomical variations is carried out on a broad scale in a number of museums of anatomy, its best exponent probably being Prof. G. S. Huntington's* beautiful collection at Columbia University. The interest of the present contribution lies merely in the fact that it presents, in the small field of cardiac anomalies, another line of approach than that of the teaching of anatomy, namely,—the explanation of the defect.

II. DISCUSSION OF LITERATURE

Several intensive studies on the elucidation of certain obscure cardiac anomalies along these lines have been published. The ground may be said to have been broken by Sir Arthur Keith² in a brilliant communication presented at the Aberdeen Tercentenary in 1906, in which he applied the researches of Langer³ and Greil,⁴ into the bulbus cordis of the reptilian heart, and his own observations upon this region in Teleost and Ganoid fishes to the explanation of the various forms of *pulmonary conus stenosis*, especially of that remarkable form, in which, through failure of the bulbus to become submerged in later embryonic development, the conus of the right ventricle remains throughout life a separate chamber, connected by a small opening (*persistent lower bulbar orifice*), with the main cavity of the ventricle.

Another interesting contribution, based in part upon this work by Keith, was made by Jane Robertson⁵ on the obscure

*This subject has recently been presented in masterly fashion by Prof. Huntington in an article (*Anatomical Record*, 1918), which came to the attention of the writers after this communication had gone to press. In it such variants are classified as (A) *Ontogenetic*, or (B) *Phylogenetic*, each of which may be again (a) *Reversional*, indicating the survival of the trait which has since disappeared in the process of development or evolution, or (b) *Progressive*, presenting features that foreshadow the future development of form towards which the human species is dimly shaping in the processes of normal evolution. Ontogenetic variants may further be due to (c) *Errors in Development*. The curious selective incidence of a "phylogenetic reversional variant" is graphically illustrated by means of a diagrammatic tree from the entepicondylar foramen of the humerus which is normal in extinct reptiles, and in certain orders and genera along the line of ascent to the human variant, and is absent in others.

²Keith. Malformations of the Bulbus Cordis. *Aberdeen Quatercentenary*, 1906.

³Langer. *Entwickelungsgeschichte des Bulbus Cordis bei Amphibien und Reptilien*. *Morph. Jahrb.*, XXI, 1894.

⁴Greil. Anatomy and Development of the Heart and Truncus Artericus in Reptiles. *Morph. Jahrb.*, XXXI, 1903.

⁵Robertson, Jane. The Comparative Anatomy of the Bulbus Cordis with Special Reference to Abnormal Positions of the Great Vessels in the Human Heart. *Journ. Path. and Bact.*, XVIII, 1913.

problem of *transposition of the arterial trunks*. In the course of an investigation into the spiral arrangement of the multiple rows of valves lining the conus arteriosus of certain orders of fishes, she correlated the evidence obtained from these studies with the researches of Greil, Langer, Röse⁶, and Born upon the *development of the bulbar portion of the aortic septum*, and applied the findings to the elucidation and verification of Rokitansky's brilliant hypothesis, published in his great work on "Defects of the Cardiac Septa,"⁷ which ascribes the phenomenon of transposition to a deviation of the aortic septum occurring in early embryonic life and placing the aorta and pulmonary artery in reversed ventricles, in relations varying with the degree of deviation and the angle of junction of the malposed aortic with the interventricular septum. In the elasmobranch fish, the primitive conus is a straight tube lined with multiple (five) rows of semi-lunar cusps horizontally placed (see Fig. V) which opens off a single ventricle and auricle and suffices to transmit the blood pumped out in a single stream to all parts of the circulation; in certain dipnoid fishes, however, the conus is twisted upon itself in its median portion and the valves lining it have assumed a spiral direction, while traces of a beginning division of the chambers by low septa appear, the whole being an adaptation to the first rudiments of the pulmonary circulation, and corresponding phylogenetically to the heart of a human embryo of 5 mm., where the bulbus has undergone a similar torsion of its distal upon its proximal end, and the endocardial swellings lining its lumen a similar spiral (See embryo Hals 6 of Tandler, Fig. II). A slightly more advanced stage of the same adaptation is seen in the grooved conus of certain amphibians (see *cryptobranchus lateralis*, Fig. IX, below). In the further evolution (mirrored in the reptilian heart with its markedly twisted arterial trunks), the endocardial swellings fuse to form the spirally placed bulbar portion of the aortic septum, (the distal pair of proximal bulbar swellings persisting in either lumen as the aortic and pulmonary cusps), and the torsion or kinking of the bulbus increases so that a long right and short left side result with a pronounced bulbo-ventricular ridge which ultimately becomes obliterated, and fusion of the free border of the interventricular septum with the contiguous auriculo-ventricular cushion occurs, placing the aorta and pulmonary artery in their respective ventricles.

In an analysis of Rokitansky's diagrams, Robertson points

⁶Röse. Comparative Anatomy of the Vertebrate Heart. *Morph. Jahrb. Bd.*, XVI, 1890.

⁷Rokitansky. *Die Defecte der Scheidewände des Herzens*. Wien., 1875.

out that the variations figured by him are to be explained by the undue development of torsion or absence of torsion of the "distal ridges" (or endocardial swellings) "in the proximal bulbar segment." In other words it is to an anomalous degree of torsion or lack of torsion of the *distal* part of the bulbus *above* the aortic cusps in relation to its *proximal* part (*below* the aortic cusps) that transposition of the arterial trunks, in all its variations, is said to be ascribed.

This elaboration of Rokitansky's explanation is further amplified and confirmed by the suggestion of Keith and Lewis, that transposition is due to a reversed torsion of the ventricular bend of the embryonic heart at a very early period of its development. Such reversed torsion has been experimentally reconstructed by Lewis and Abbott⁸ in the hearts of two embryos of 4.8 mm. and 10 mm. long, with results indicating that an incomplete twist of less than 180° would place the great trunks in reversed ventricles. That this actually may occur is proven by a plate in Remak's Atlas of the heart of a chick embryo at the early tubular stage before pouching forward of the auricles had occurred, in which the ventricular portion is bent abnormally on the left side, while a second heart at the same stage with the normal bending of the ventricular tube to the *right* is shown in the same plate for comparison. That such torsion or reversed torsion would begin at the distal rather than the proximal (ventricular) end of the bulbus is proven by the fact that ventricular bending is known to start at the cephalic end of the cardiac tube.*

The value of such phylogenetic and ontogenetic studies in relation to the origin of *cardiac septal defects* became evident to one of us (M. E. A.) in connection with a study which we were privileged to make through the courtesy of Dr. W. F. Hamilton, of a case of ruptured aneurysm of the right aortic sinus of valsalva with associated defect of the anterior interventricular septum, directly below the right (anterior) aortic cusp⁹. (See Fig. I). In this case the nature of the anatomical lesions was obscured by a malignant endocarditis of the aortic and pulmonary valves and conus, walls of the aneurysm and margins of the defect; but in the light of a practically identical series of cases in the literature reported

*An interesting sidelight upon the causation of torsion and its reverse is given in a recently published study by Bradley Patten on the "Formation of the Cardiac Loop in the Chick." *Amer. Jour. of Anat.*, 1922, XXX, 373.

⁸Lewis and Abbott. Reversed Torsion of the Human Heart. *Anat. Rec.* 1915.

⁹Abbott, M. E. Aneurysms of the Right Aortic Sinus of Valsalva. Contributions to Medical Research, July 12th, 1919. Paul B. Hoeber.

by Rickards¹⁰, Hale White¹¹, Kraus¹² and others, in which no sign whatever of inflammation of the endocardium was present, a congenital origin of the two openings might fairly be concluded. In all these cases the location of the associated ventricular septal defect was unusual in that, as has been said, it lay in the *anterior* part of the septum, and opened into the *conus* of the right ventricle just below the pulmonary valves, whereas the usual position of septal defects is further back, just anterior to the pars membranacea septi, and opening into the sinus of the right ventricle behind or below the tricuspid valve segment. These two locations of defects of the interventricular septum at its base, and the relative rarity of those in the anterior part, has been commented upon by Rokitansky and others, and the questions arise: Is there a different embryological explanation for defect in the anterior septum from that which applies to defects in its more posterior part? and, do the facts of embryology and comparative anatomy yield any explanation of the combined defects above and below the right aortic cusp seen in the series of cases here illustrated (see Fig. I.)?

The answer to these two questions was obtained from the study: (a) of the heart of the turtle (see Fig. X), in which the communication between the dorsal and ventral parts of the ventricle lies behind the right border of the heart (corresponding to the anterior surface in the human subject), constituting a large semi-lunar opening bounded to the right (or anteriorly) by the concave free border of the bulbo-ventricular ridge, which is derived from and therefore a part of the bulbar (aortic) septum. Persistence of this opening in the human heart would mean, therefore, a defect in the extreme anterior or bulbar part of the interventricular septum; while persistence of the true interventricular foramen, (Fig. X, i.v.f.) that is, of the passage lined with endocardium between the left and right halves of the dorsal ventricles in the turtle, which becomes closed in the crocodile and mammalian heart to form the aortic vestibule by the growth upward of the interventricular septum proper to join the right endocardial cushions of the auriculo-ventricular plug and the posterior border of the bulbar septum, would be represented by a defect further back in the interventricular septum of the human heart, at or just

¹⁰Rickards. Communication between the Aorta and Pulmonary Artery and Between the Right and Left Ventricle. *B.M.J.*, 1881, II, 71.

¹¹Hale-White. Patent Ventricular Septum with Aneurysm of Base of Aorta opening into the Right Ventricle. *Trans. Path. Soc. Lond.* 1891-92, XLIII, 34.

¹²Kraus. True Aneurysm of the Right Aortic Sinus of Valsalva. *Berlin Woch.*, 1902, XXIX, 1161.

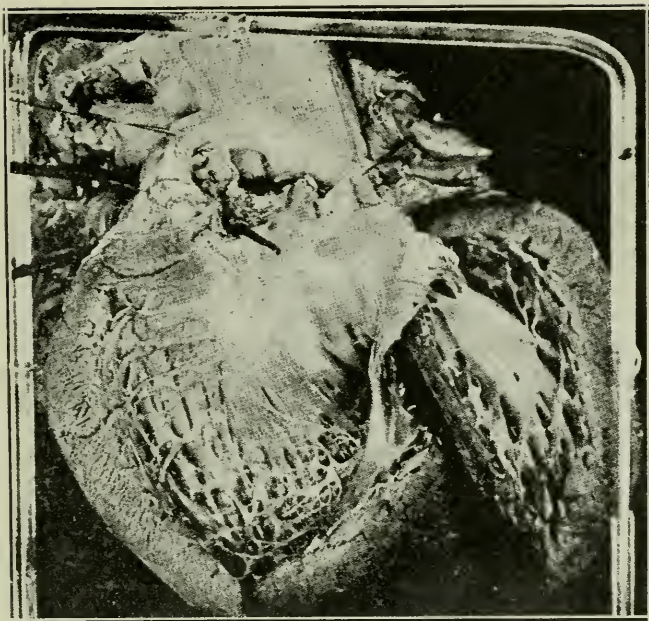


FIG. I.

Aneurysm of Right Aortic Sinus of Valsalva, rupturing into right ventricle at level of pulmonary valves, associated with opening in interventricular septum leading into conus arteriosus of right ventricle. Malignant endocarditis. The interventricular communication lies directly below the anterior half of the right aortic cusp in the extreme anterior (bulbar) part of the interventricular septum. From a case in the service of Dr. W. F. Hamilton in the Royal Victoria Hospital, Montreal. Specimen presented to the Pathological Museum of McGill University by Prof. Horst Oertel.

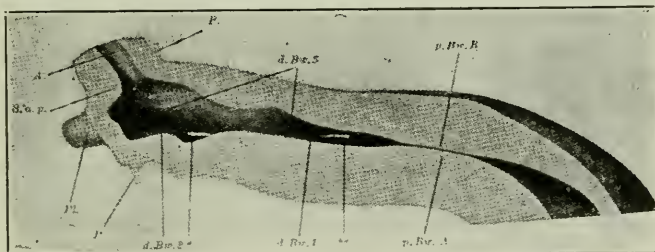


FIG. II.

Left half of Model by Julius Tandler of the *Bulbus Cordis of the Embryo I16* divided longitudinally. Showing stage of development in which the distal bulbar swellings 1 and 3 (from which the aortic and pulmonary cusps originate) have fused to form the distal bulbar septum, the proximal bulbar swellings (p. Bw. A.B.) have fused to form the proximal bulbar septum, and the septum aortico-pulmonale (S.a.p.) has grown downward for a short distance, leaving two points of communication between the aortic and pulmonary trunks, immediately above and below the distal bulbar (aortic and pulmonary cusps).

"A," Aorta (4th Aortic Arch); D.Bw. 1-3, Distal Bulbar swellings; P. pericardium; Pl. Pulmonary Artery (Sixth Aortic Arch); *points at which the sound of the lumen of the pulmonary artery appears, being covered by the fusion of the distal bulbar swellings 1 and 3, forming the distal bulbar septum.

From Keibel and Mall's "Embryology", Vol. II, Fig. 384. p. 552.

anterior to its pars membranacea; of the heart of the python (see Fig. XI) which is especially interesting in this connection, in that it shows these two openings, (a) between the ventral and dorsal chambers, and (b) between the right and left halves of the dorsal ventricle, the one (A.C.) lying above and to the right in that part of the septum derived from the bulbus cordis and communicating also with the third ventricle giving off the left aorta; the other below and to the left and posteriorly above the muscular upper free border of the (true) interventricular septum, and communicating both with the ventral ventricle and with the two valves of the dorsal ventricle (P.C. and I.V.F.); (c) *the heart of the crocodile* (see Fig. XII) which shows the closure of both these openings in a complete interventricular septum with upper membranous part, and which presents also what may be considered a homologue of the congenital thinning and aneurysmal bulging with subsequent rupture of the right aortic sinus of valsalva (see Fig. I), in the *foramen panizzae* which is a subsidiary opening established behind the contiguous semilunar cusps of the left (venous) and right (systemic) aorta (Fig. XII); (d) finally, this combination of defects *above* and *below* the right aortic cusp is shown by comparison with a reconstruction by Tandler of the bulbus cordis of the human embryo of 6.65 mm. (Fig. II) to represent the persistence of a stage in which a double opening exists at the two points which close in last in the process of fusion of the bulbar endocardial swellings, in that part of the aortic septum which divides the base of the aorta from the pulmonary artery and the upper and anterior portion of the left ventricle from the right. A longitudinal section of this model (Fig. II) shows the division of the primitive arterial trunk proceeding at three points, (a) above by the growth downward from above of the septum aortico-pulmonale; (b) in the middle by the fusion of distal bulbar swellings 1 and 3, to form the *distal bulbar septum from which originate the pulmonary and aortic cusps*; (c) below, in what is to become by the fusion of the "proximal bulbar swellings" *the upper and anterior part of the interventricular septum* of the mature heart. Between these three points, that is above and below the distal bulbar septum or level of origin of the aortic and pulmonary cusps, two communications exist, through which in the model (see Fig. II) a probe has been passed.

From these observations it is obvious (1) that in defects of the anterior interventricular septum *situate below the right aortic cusp and opening into the conus of the right ventricle, the communication lies in the bulbar or aortic septum* and is due to an arrest of growth before fusion of its endocardial cushions was completed,

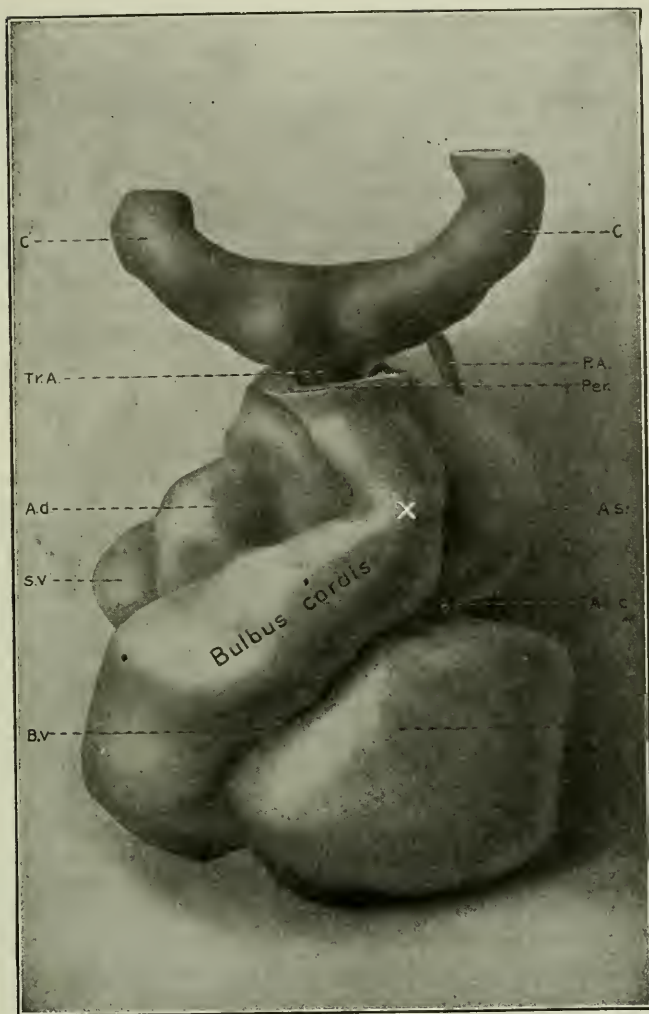


FIG. III.

Model of the Heart of a Human Embryo 4.6 mm. Long x 108, to Show the Relation of the Embryonic Bulbus Cordis to Ventricle and Aortic Arches.

(The Division of the Bulbus Cordis into Aorta and Pulmonary Artery begins a little above the level of the Bulbo-Ventricular Cleft (B.v.), and from this point to the level of the Aortic Semilunar Cusps the "Bulbar" Septum Forms the Anterior Part of the Interventricular Septum of the Heart.) C., Carotid Arch; P.A., Pulmonary Artery; Per., Pericardium; Tr.A., Truncus Arteriosus; A.d., Right Auricle; A.s., Left Auricle; A.u.c., Common Auriculoventricular Orifice; B.v., Bulboventricular Cleft; V., Common Ventricle. Model by F. T. Lewis and M. E. Abbott, (Dr. Begg's Embryo.)

while defects of the adult human interventricular septum situate more posteriorly at or just anterior to the pars membranacea and *opening into the right ventricle behind or below the tricuspid valve*, are to be explained by an arrest of growth of the upper free border of the interventricular septum; and (2) that a congenital thinning or defect of the right aortic sinus opening into the pulmonary artery at or near the level of its cusps, is likewise due to the persistence of an opening in the primitive bulbar septum, or that part of it which lies distally to the portion from which the aortic and pulmonary cusps are derived, and that (3) the combination of a second defect below the same (right) aortic cusp represents an arrest of the bulbar septum at the stage of its development in which defects above and below the level of the aortic cusps exist, as shown in Tandler's model (Fig. II).

III. ILLUSTRATIVE MATERIAL

The foregoing statements are intended merely to emphasize the value of the correlation of objective material from comparative anatomy, embryology and antenatal pathology along the lines attempted in connection with the collection of cardiac anomalies in this museum. In this connection it is obvious that certain finer points in the evolution of the vertebrate heart, especially of the complicated regions of the bulbus cordis and aortic and interventricular septa, are necessarily represented in this collection, which is primarily pathological, by pictures or lantern-slides made from the figures or models reproduced in the publications of Langer, Boas, Gegenbaur, Röse, Greil, Keith, Balfour and others, on whose brilliant researches in the field of comparative embryology our exact knowledge of this subject is based.

The comparative collection was begun with a representative series of hearts from the various species of Teleost and Elasmobranch fishes obtained by one of us (E. S.) for the purpose, at the Biological Station, St. Andrews, N.B., in the summer of 1918. The specimens of other (higher) orders and classes have been obtained by gift or purchase since then, from the Southern Biological Station, the Scripps Institution for Biological Research of La Jolle, California, (through Mr. Barnhart), the Biological Station at Woods Hole, Mass., and Bar Harbour, Maine, (Harp-swell Laboratory), the New York Aquarium, and the Princeton Museum of Zoology and U. S. National Museum through Dr. Silvester; the series is still fragmentary, hearts from dipnoid fishes and the various orders of amphibia and reptiles, as well as cardiac

anomalies of obscure origin, are desired from members of this Association for the purpose of this research.

The specimens are grouped under the various orders of the vertebrate kingdom in the line of ascent from the primitive teleost fishes to the stage of complete development of the cardiac septa shown in the heart of the crocodile. The teleost heart is here placed first, or lowest in the scale, although it is usually classified higher than fishes of the Ganoid and Elasmobranch orders, because it presents the closest approach to the early tubular form of the embryonic heart.

A. FISH HEARTS. CLASS PISCES

I. Order Teleostei:

1. *Lophius piscatorius* (Heart of Angler). Fig. IV a and b.

Type Specimen

A large fish heart of the so-called primary four-chambered venous type without ventricular bend or division of chambers. The common auricle not yet ascended but lying below the common ventricle with sinus venosus entering it from below and the large conical bulbus arteriosus above and anteriorly; the latter is in these fishes a specially differentiated structure with thick fleshy walls and pyramidically shaped cavity constricted below where it joins the ventricle to a narrow bulbo-ventricular neck, and giving off two pairs of aortic arches from its cranial (free) end; with a broad flat base which is apposed to and rests upon the upper surface of the ventricle, to which it is joined by a constricted portion, the bulbo-ventricular neck. This is a narrow passage with thin, tendinous walls supplied internally with a single large pair of semilunar cusps guarding the bulbo-ventricular orifice, and represents all that remains in these fishes of the conus arteriosus or bulbus cordis of the other lower vertebrates, and of the human embryo, this structure being in the case of the teleost rudimentary or submerged. The common ventricle lies directly below and somewhat anteriorly to the bulbus arteriosus and is a flattened ovoid structure the size of a walnut with spongy musculature and small cavity vertically placed which widens below sending prolongations downward between the trabeculae and presenting on the lower part of its posterior wall a little to the left side the circular common a.v. orifice guarded by two large endocardial cushions; the auricle is thin-walled and of triangular shape with roomy cavity lined by loose musculature; it presents on its postero-inferior wall the large sinu-auricular opening obliquely placed, and guarded by two long thin cusps. The sinus venosus is situated transversely below the auricle and receives a small and large vein at either end. The parietal pericardium is reflected above upon the bulbus at the origin of the aortic arches and below upon the sinus venosus.

Other Teleost hearts in the collection showing minor variations but the same essential structure are the following:

2. *Pollachius virens* (Pollock).
3. *Gadus aeglefinus* (Haddock).
4. *Merluccius vulgaris* (Hake).
5. *Prionotos Americanus* (Sculpin).
6. *Zoarces* (Eel-Pout).
7. *Salmonides* (Salmon).

The following present adaptations to the peculiar form of the fish:

8. *Anguilla vulgaris* (Eel). The heart is the shape of an elongated cone and appears like a tightly curled leaf, the thin and voluminous wall of the asymmetrical auricle being closely wrapped around the slender elongated bulbus and ventricle, to which and to the pericardium it is attached by delicate fibrous adhesions. The ventricle has a sharp anterior border which is prolonged upward in front of the bulbus and downward to form an apex.

9. *Pleuronectes Americanus* (Flounder). The heart is reflected like the other organs of this fish through a right angle.

Remarks: The heart of the Teleost fish is a simple force pump which mirrors the very early tubular embryonic heart; the massive development of the bulbus arteriosus and the reduction of the bulbus cordis proper to a small canal with tendinous walls

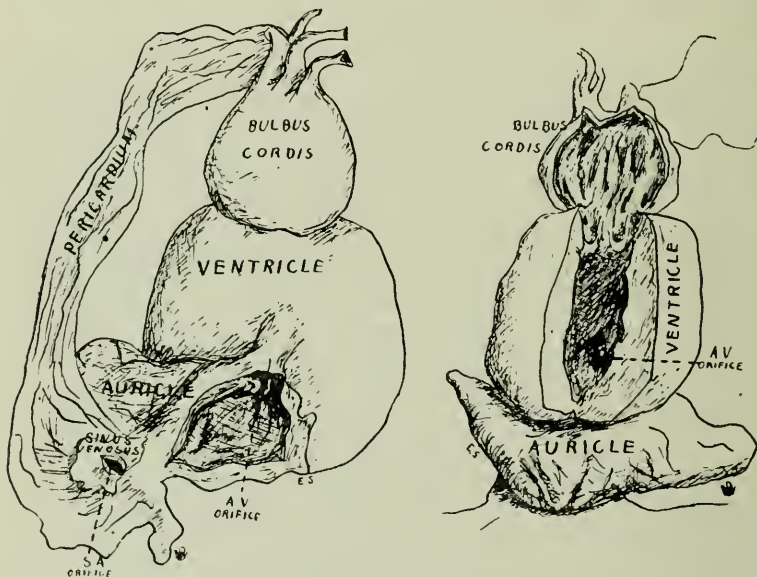


FIG. IV.

*Heart of Angler (Lophius piscatorius) Order Teleostei
Type Specimen*

(a) *Posterior Surface.* Note the low position of the auricle which has not yet ascended above the ventricle and the bicuspid valves guarding the sino-auricular and the auriculo-ventricular orifices; also large fleshy bulbus arteriosus with narrow bulbo-ventricular neck (rudimentary conus).

(b) *Anterior Surface.* Laid open to show interior of ventricle and bulbus arteriosus. Note the roomy cavity and grooved internal surface of the latter and the single pair of semilunar cusps which guard the bulbo-ventricular orifice; also situation of auriculo-ventricular orifice in median line directly below bulbo-ventricular orifice and position of auricle directly below ventricle. Primitive type.

From a specimen in the Pathological Museum of McGill University, presented by Miss E. Shanly.

containing a single pair of semilunar cusps guarding the bulbo-ventricular orifice, are peculiar features which have apparently disappeared from the life cycle of the human embryo as they have from the majority of other species of the lower vertebrate orders. In relation to cardiac anomalies this structural arrangement is of especial interest in elucidating that form of pulmonary stenosis in which the bulbus remains a separate chamber, and a constricted "lower bulbar orifice" persists below it. This type of anomaly is figured by Keith and is illustrated in our collection by two cases, in one of which, No. 14,131², two distinct semilunar cusps, partly muscular in structure, are situate at the junction of the conus with the sinus of the ventricle.

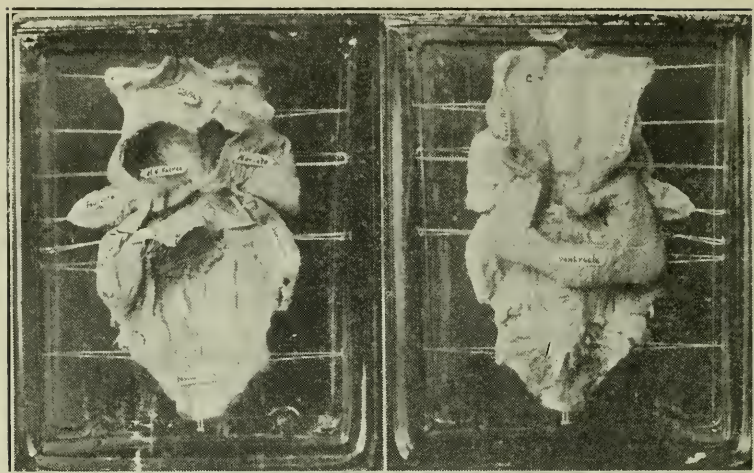
II. Order *Elasmobranchii*:

2. *Raia Erinacea* (Heart of Skate). Fig. V.

Type Specimen

A primary four-chambered heart without division of chambers, but with definite ventricular bend to the right and the auricle ascended behind the ventricle. The bulbus arteriosus is absent and the conus is elongated into a straight tube, with thick, fleshy walls lined by four rows of semilunar cusps, three in each row, placed directly above each other in vertical columns divided by a distinct interval without any attempt at spiral arrangement or retrogression as in *lepidosteus*, (see below), all the cusps being of nearly length with broad triangular upper border, and of mucoid structure. The conus passes directly upward from the right upper border of the ventricle. The latter is a roughly pyramidal structure flattened from before backward and slightly convex from side to side anteriorly. A portion of the anterior wall has been cut away to expose the interior, which is composed of heavy trabeculated muscle, surrounding a U-shaped cavity, from the right upper angle of which the conus arteriosus arises, while the left upper angle receives the common auriculo-ventricular orifice, which admits a slate pencil and is screened in its left angle by the passage into the ventricle of a prolongation from its endocardial cushions (*chordæ tendineæ*). The two orifices are on the same antero-posterior plane, but are separated from each other by a heavy whorl of musculature. Just below the bulbar orifice on the posterior wall of the ventricle is a round sinus leading into the musculature between its trabeculae, and smaller apertures of similar character are adjacent.

The common auricle lies above and behind and has very thin walls with angles above which pouch forward on either side of the bulbus cordis and the upper part of the lateral walls of the ventricle. Interiorly the chamber is lined by several scattered muscoli pectinati, and it presents on its anterior wall a depression caused by pressure from the conus arteriosus; there is no other trace of auricular septum; behind and to the right of the a.v. orifice, passing obliquely from the left posteriorly to the right anteriorly are two large valvulae venosae sinistra et dextra which arise from the floor of the auricle and guard the opening into it of the sinus venosus. The left is the larger and stronger of the two, and is directly interposed between the sinu-auriculo and the auriculo-ventricular orifice. The sinus itself is an elongated roomy cavity transversely placed along the posterior lower border of the auricle, directly adherent to its floor and curves downward and outward to receive a large venous trunk at either ex-



B. POSTERIOR VIEW

A. ANTERIOR VIEW

FIG. V.

Heart of Skate (Raia Erinacea).

A-Anterior View. Elongated Conus Arteriosus lined by four horizontal rows of cusps (c) arranged in three vertical columns given off from right upper angle of common ventricle which has fleshy walls and communicates on the left side posteriorly by a common auriculo-ventricular orifice with a single auricle which pouches forward from above on either side of conus.

B-Posterior View. Common auricle lies above, is laid open, and shows absence of auricular septum. Mucoid bicuspid valve of common a.v. orifice on left side inferiorly. Sinus Venosus lying transversely below the auricle and opening into its floor slightly to left of median line through oblique orifice guarded by valvulae venosae sinistra et dextra (v.v.d. only visible). Pericardial sac below with central opening admitting probe leading into peritoneal cavity.

From a specimen in the Pathological Museum, McGill University, presented by E. Shanly.

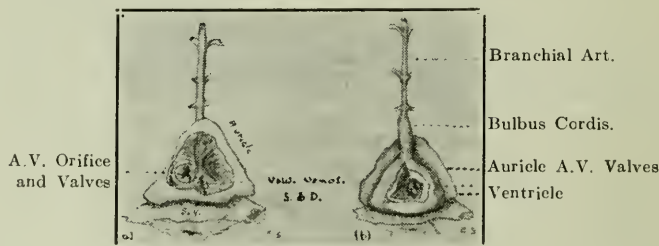


FIG. VI.

Heart of Chimera Collei. Order Holocephali.

(a) *Ventral View.* Long slender bulbus with constricted neck which encloses two rows of semilunar cusps arising from single ventricle slightly to right of median line which receives common a.v. orifice in ventricle slightly to left, and large common auricle above and behind ventricle pouching forward on either side.

(b) *Dorsal View.* Shows interior of auricle, common a.v. orifice to left and sino-auricular orifice to left guarded by bicuspid valves, S.V. Sinus venosus below. From a specimen in the Pathological Museum of McGill University.

tremity. The pericardial sac attached presents the pericardio-peritoneal aperture, and a cartilaginous process of attachment to the shoulder girdle.

Other Elasmobranch hearts in the collection are:

2. Heart of Dogfish (*Family Scylliida*).
3. Heart of Shark (*Family Carchariidæ*).

The following specimen closely resembles the above:

III. Order *Holocephali*:

1. *Chimaera Colliciei*. Fig. VI.

A small heart with long conus arteriosus supplied with two rows of four semilunar valves given off from the upper angle of a common ventricle which has an S-shaped cavity and receives a common a.v. orifice below and behind, and to the left. A large common auricle with prominent appendages projects forward on either side of the conus above the ventricle; it has a thin-walled cavity and presents the auriculo-ventricular orifice on its left anterior inferior wall guarded by three endocardia cushions. Behind and to the right of this is the opening of the sinus venosus guarded by two strong v.v. *sinistra et dextra*, which pass obliquely backward from the median line along the floor of the auricle. There is no trace of an interventricular septum, but the conus arteriosus makes a distinct indentation in the anterior wall of the auricle. The sinus venosus is a transverse thin-walled sac attached to the floor of the auricle along its middle third, and receives a large vein at its right and left angles. A portion of the pericardial sac is attached and shows the pericardio-peritoneal foramen.

Remarks: The remarkable heart of the Elasmobranch fish, and to a less extent, that of the *Chimaera Colliciei*, is extremely interesting from the comparative standpoint, for it shows very clearly the stage of the human embryo of 4 mm. after torsion of the ventricular loop has occurred but *before* the development of the septa, in which the common arterial trunk arises from the right upper angle of the common ventricle and the common orifice enters this entirely on the *left* side. (Compare Fig. III). In relation to cardiac anomalies, this stage is of much interest as explaining the so-called *rechtslage* of the aorta common in pulmonary stenosis with septal defect and invariable in persistent truncus arteriosus, or complete defect of the aortic septum where the large single arterial trunk of necessity arises entirely from the right ventricle, the arterial blood being transmitted to it from the left chamber through a septal defect. The large *valvulæ venosae dextra et sinistra* are of much interest as illustrating the embryonic conditions that persist in anomalous septa in the right auricle, fenestrations on the auricular septum, etc.

IV. *Order Ganoidei*:

- 1.
- Lepidosteus Osseus*
- (Bony Pike). Fig. VII. a and b.

Type Specimen

The bulbus cordis or conus arteriosus is lined with eight transverse rows of valves presenting three stages of development (*vide* Stöhr¹³) Fig. VII-b; longitudinally these present four rows of large well formed semilunar cusps. The four most distally placed are considerably larger and more developed than the succeeding rows. They possess also a free margin while the cusps of each succeeding row are bound down by prolongations from their margins uniting them with the base of the previous row, and with the substance of the bulbar wall. Alternating with these valves of the first class are four incomplete longitudinal rows of cusps much less developed and for the most part bound down as in the previous class; still a third class of extremely degenerated valves is to be seen in four incomplete longitudinal rows occurring in some cases between those of the first and second rows, as is clearly seen in the figure.

The ventricle is a pyramidal structure with broad anterior and two equal posterior surfaces sloping backward to meet in the dorsal median line. The bulbus cordis enters just to the right of this. Inside is a slight ridge from which smooth, fine trabeculae run to unite with spongy musculature, completely filling the whole ventricle, save a narrow channel slightly to the right of the central line. A little below the entrance to the bulbus cordis is the auriculo-ventricular aperture guarded by two large semilunar valves. The auricle rises slightly above the ventricle enfolding the bulbar neck and upper surface; it has relatively small, thick spongy walls and presents a ridge above the auriculo-ventricular flap which appears as a projection from the bulbar wall extending into its cavity, indicating beginning division of the auricle. This chamber is prolonged anteriorly into two arms of about equal size; each of these receives a sinu-auricular orifice guarded by two fleshy, much fluted horizontally placed valves (double sinu-auricular orifice); these openings are opposite to and slightly above the a.v. orifice; the left is somewhat larger than the right.

Another Ganoid heart in the collection is:

- 2.
- Acipensor*
- (Heart of Sturgeon). Presents a slender conus containing four horizontal rows of semilunar cusps of approximately equal size. The sinu-auricular orifice is here single as usual (not double as in
- Lepidosteus*
-).

Remarks: The heart of the Ganoid fish has been placed by us after that of the Teleost and Elasmobranch, because, although ventricular torsion has apparently not proceeded far, the auricle has arisen above and behind the ventricle, and *division of its cavity* has begun. The peculiar arrangement of the valves lining the conus of *lepidosteus* (Fig. VII-b) indicating a progressive retrogression of certain rows of cusps and the persistence of others, represents an intermediate stage of development between the straight conus of the Elasmobranch and the spiral torsion seen in certain dipnoid fishes (of which we have unfortunately as yet

¹³Stöhr. *Ueber den Klappen Apparat im Conus arteriosus der Selachien u. Ganoideen.* *Morph. Jahrb.*, 1876, II, 197.

¹⁴Smith, Wilbur C. On the Process of Disappearance of the Conus Arteriosus in Teleosts. *Anat. Record*, 1919.

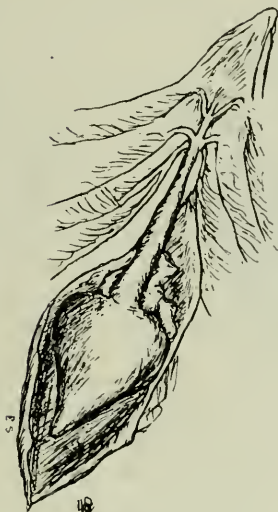


FIG. VII-a.

(a) Heart of Garpike (*Lepidosteus osseus*). Anterior view.

From a specimen in the Pathological Museum of McGill University, presented by Dr. W. W. Beattie. 1 1/2 x 1 1/2

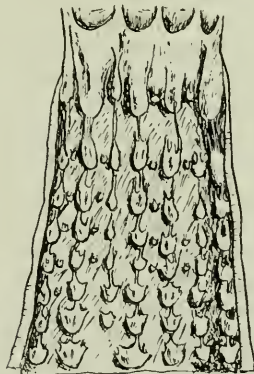


FIG. VII-b.

(b) *Lepidosteus Osseus*. Bulbus laid open to show the numerous rows of valves lining its lumen of different stages of development, the smaller, more rudimentary ones, indicating retrogression to the simpler condition of fishes of higher order in which only the upper and lower rows of cusps persist. (After Stöhr).

no representative), as well as in the amphibian and reptilian heart (see Figs. VIII to XII), and in the spiral arrangement of the endocardial swellings of the human embryonic bulbus at the stage shown in Fig. II. As has been remarked above, such torsion, or absence of torsion, is of much interest in relation to the elucidation of the problem of transposition of the arterial trunks (Robertson). The double sinus venosus in this fish is a condition unique in this species. Its persistence or reappearance in the human subject has been observed by us in a case recently reported.

With the above series of fish hearts this collection, as a detailed study of the comparative anatomy of the heart, ends for the present. Specimens of the dipnoid order have not yet been available to us. The following five representatives of the tailed batrachians and the three orders of reptilia have been added as mirroring in a general way later stages of the embryonic heart corresponding with the advancing establishment of the double circulation. The latter are of especial interest to us in reference to the study of cardiac septal defects:

B. CLASS AMPHIBIA

I. Order Urodela:

1. *Heart of Mud Puppy—Necturus (Family Proteidae). Fig. VIII.*

(For detailed description see inscription below illustration.)

Remarks: Externally the heart of *Necturus* is somewhat fish-like, notably from the slight slant from left to right of its long axis and in the persistence of a large and independent sinus venosus. The broad axis now becomes marked. With the addition of the pulmonary arteries to the circulation the bulbus arteriosus has become more capacious. It passes down to the right of the auricle which curves forward beneath it, entering the upper right hand corner of the ventricle. At either end of the conus is a row of three or four semilunar cusps. At the amphibian stage of progression a definite spiral twisting of the bulbus commences, usually accompanied by a longitudinal valve attached along the axis of the spiral. Primitive indications of this are seen in the specimen of *Necturus*. The ventricle is distinguished by its musculature. The greater part of its volume being occupied by trabeculae. These are permeated by irregular holes forming a spongy network draining into a common cavity at its base, the forerunner of the functionally divided ventricle. The entrance to the auricle is guarded by a valve system. This chamber in *Necturus* is a triangular unlobed structure, lying above and curving over the ventricle. It is a disputed point whether the auricu-

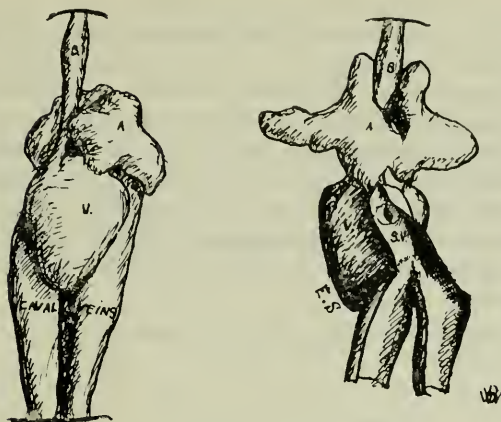


FIG. VIII.

Heart of Mud Puppy (Necturus).

(a) *Anterior View* showing a straightening of its long axis from the typical left to right below slant seen in fishes. The broad axis has become marked. The bulbus is a capacious cord-like structure. The auricle gives no external indication of the commencing of an internal division.

(b) *Dorsal View.* The sinus venosus is the large independent structure met with in a lower stage of development. It is opened to show the large sinu-auricular orifice and the ridge indicating the common entrance of the precaval and posterior veins.

From a specimen in the Pathological Museum of McGill University.

lar septum is recognized at this stage; we were unable to verify this in *Necturus* from limitation of material, only one specimen being available to us. However, the pulmonary veins join and run over the middle of the border of the sinus, entering the auricle on its left side as yet unguarded by valves, while the blood from the systemic vein enters through the sinus venosus below and entirely to the right. The sinus lies more forward on the dorsal side of the auricle; its auricular portal is small but the valves are somewhat less mucoid than in the earlier form.

2. *Cryptobranchus lateralis* (Heart of Salamander,) (Family *Amphiuma*)
Fig. IX.

Remarks: The salamander is a tailed Batrachian. In its adult stage it is without gills unless it is compelled to mature under water. Its heart presents a completely straightened axis with the bulbar neck curving over the top of the auricle. Its advance in evolution is characterized by the fuller division into two arterial channels, in the conus by deep grooving, and beyond its row of cusps by the expansion of the truncus arteriosus to form two bulbus fundaments of the aortic arches dividing ventrally into the

systemic arches and dorsally into the pulmonaries. The advance is continued to a further stage in the ventricle, where the figures (IX, a and b) show an aggregation of the permeable muscle resulting in the definite structure of a venous canal on its left side. There is a distinct though incomplete auricular septum highly perforated in its upper area, dividing the auricle into a right half receiving venous blood from the body and a smaller left half receiving venous blood from the lungs. The position of the orifices, associated with a delicate adjustment of tensions causes a mechanical partition forerunning the anatomical division discerned in the reptilian heart.

For further description see below illustration.

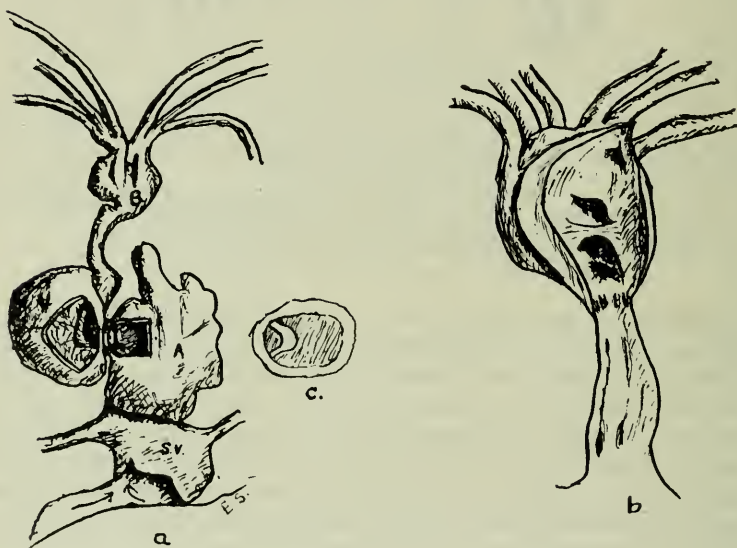


FIG. IX.

(a) Heart of Salamander (*Cryptobranchus lateralis*). Anterior view with ventricle (V) everted to the right and auricle (A) to left. Note the elongated and spirally twisted bulbus cordis (b) with bifurcation above into three pairs of aortic arches, indicating a more advanced adaptation to the double circulation than in *Necturus*. Windows have been cut out of the anterior wall of the ventricle and auricle to show the auriculo-ventricular orifice and the appearance in the ventricle of a narrow cylindrical channel from which the arterial blood is expelled into the systemic arches, and the spongy musculature to the right of this, with which the venous blood flows to be put forward in the second phase of ventricular systole into the pulmonary arches.

(b) Bulbus of Salamander laid open to show the interior division of the conus by grooving, and the four rudimentary cusps at its distal end beyond which the bulbar neck is expanded into two bulging chambers from which lead two pulmonary and two systemic entrances to the six great aortic trunks.

(c) Auriculo-ventricular valves. Note their unequal size, the right cusp becoming smaller and approaching the trabecular condition of higher vertebrates.

From a specimen in the Pathological Museum of McGill University.

C. CLASS REPTILIA

I. Order Chelonia:

1. Heart of Snapping Turtle (*Chelonia Midas*). Fig. X. a and b.

Remarks: The turtle illustrates the three-chambered reptilian type of heart, having two large auricles pouching over the ventricle on either side but entering the upper surface of the latter to the left of the median line. The atrio-ventricular sulcus is still deep. Conforming to the shape of the body there is a large flattened semilunar ventricle rounded at the apex, showing no grooving on its convex surface. Its wide upper border gives off the truncus arteriosus from the right angle above and anteriorly in front of the auricular canal. The interior is completely divided into dorsal and ventral chambers by the bulbo-ventricular ridge, which is a prolongation downward of the septum aortico-pulminale. A small triangular ventral chamber occupying the right half of the anterior surface, gives off the pulmonary artery

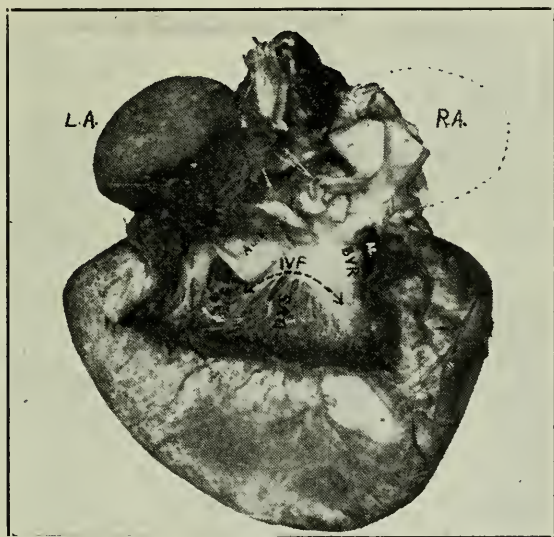


FIG. X.

*Heart of Turtle (*Chelonia Mydos*).*

(b) *Posterior (Dorsal) View* showing large dorsal ventricle receiving blood from both auricles and giving off the right aorta, large auriculo-ventricular flap (Au.V.) projecting downward from base of auricular septum (everted in specimen) and loose musculature of the incomplete interventricular septum (D.V.S.) which projects upward in the median line to meet the endocardial cushions of the bulbar and auricular septa leaving an opening, the interventricular foramen (I.V.F.) between the right and left halves of this dorsal ventricle; second opening (A.C.) at the right margin between the bulbo-ventricular ridge (B.V.R.) and right (anterior) wall of the heart.

and the left aorta separated by the bulbo-ventricular ridge. These vessels together with the right aorta, firmly united in their outer coats, constitute the truncus arteriosus. The lumen of each is completely independent and each is provided at its orifice with two large semilunar cusps. The bulbo-ventricular ridge is muscular below but covered with endocardial tissue above, and corresponds to the ventral part of the interventricular septum (as is well seen in the crocodile). The dorsal ventricle occupies the whole breadth of the dorsal surface of the heart. It gives off the right aorta at its right upper extremity and receives the orifices of both auricles. Its walls are of thick spongy musculature and this is aggregated in a series of trabeculæ on its anterior and posterior walls which ascend in the median line to meet the endocardial cushions of the auricular canal, leaving a large space between them through which the blood passes from the left auricle to the right aorta. The auricular septum is entire and is expanded below into two large septal cusps of secondary origin which spread into the mouth of the auricular canal of both auricles and act

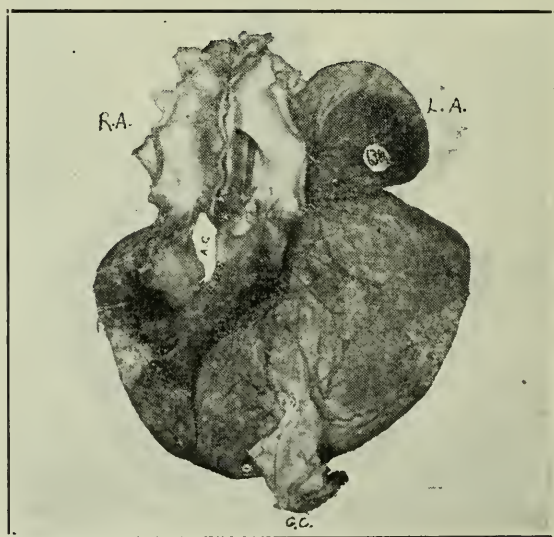


FIG. X-a.

Heart of Turtle (Chelonia Mydas).

(a) *Anterior (Ventral) View*, showing small ventral ventricle, giving off pulmonary artery and left aorta; bulbo-ventricular ridge (B.V.R.) with large crescentic opening (A.C.) to the right of this between its free border and the right wall of the heart; R.A. the space occupied by the right auricular appendix, which has been cut away; G.C. Gubernaculum cordis.

From a specimen in the Pathological Museum, McGill University.

alternately like paddles, allowing the blood from the *right auricle* to reach the *pulmonary artery and left aorta* and that from the left auricle to reach the *right aorta*. A single large pulmonary vein enters the left auricle and the sinus venosus opens into the right auricle after receiving all the precaval and post caval veins. This stage of development mirrors an embryonic heart of five weeks.

For further description see illustration on next page.

II. ORDER OPHIDIAE

1. *Heart of Python*. Fig. XI. a and b.

Remarks: The ophidian heart is found in situ, wedged in on the right of œsophagus. It therefore presents a somewhat constricted egg-shaped appearance. The gubernaculum cordis is characteristically absent. The heart of the python appears essentially similar externally to the heart of the turtle, but internally an advance is seen in the development of the ventricle. The endocardial tissue of the bulbo-ventricular ridge on the right wall of the ventricle forming an incomplete interventricular septum while below and to the left a defect appears in the muscular trabeculae communicating with the left half of the former (anterior) ventricle, so that the ophidian heart has apparently three chambers, a ventral one giving off the pulmonary artery and communicating by a narrow anterior slit in front of the bulbo-ventricular ridge with the dorsal ventricle, the smaller highly muscular upper left portion. This is imperfectly divided into a right half receiving the left auriculo-ventricular orifices and communicating in the trabeculae of its wall with the "cavum pulmonale" of the ventral ventricle and a left half receiving the right auriculo-ventricular aperture and giving off both the aortic orifices to the right of the extreme upper edge of the bulbar septum. As in the turtle the auriculo-ventricular orifices are guarded by longitudinal valves. One of these in each case spreads out in a broad membranous flap from the septal side of the margin of the a.v. aperture, functioning, as in the turtle, in such a way that the dorsal ventricle is divided into a *cavum venosum* receiving aerated blood from the left atrium, and a *cavum arteriosum* conducting aerated blood from the right atrium into the aortae.

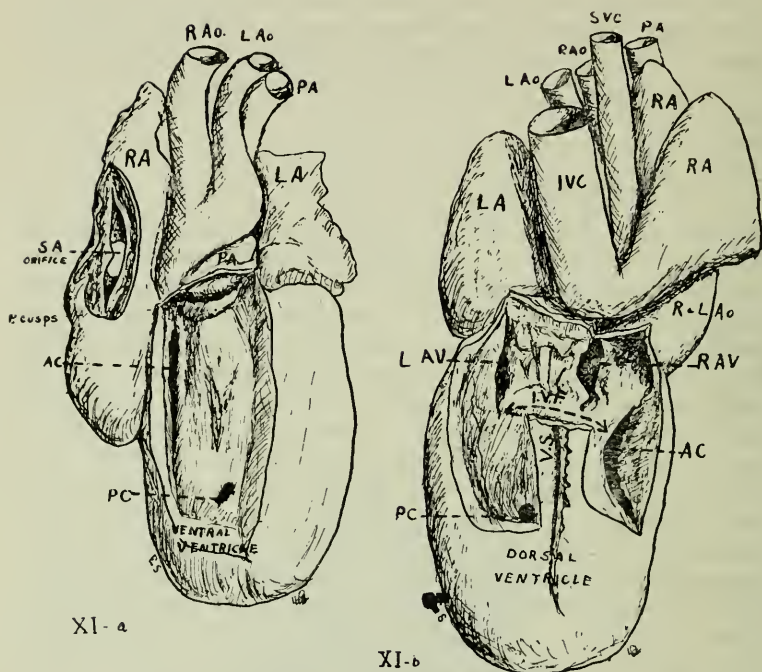


FIG. XI, Heart of Python

(a) *Anterior (Ventral) View* showing (1) large pulmonic (ventral) ventricle which presents two orifices of communication with the dorsal ventricle, one posteriorly or to the left and inferiorly (P.C.) of small size, which transmits venous blood to the pulmonary artery (P.A.), and the other situate anteriorly or to the right and above (A.C.) which is a long slit-like aperture between the right free border of the bulbar septum and the right wall of the ventricle; (2) the large truncus arteriosus containing the pulmonary artery and left and right aortas twisted upon each other; and (3) the large elongated right auricle with sinu-auricular orifice guarded by two vertically placed *valvula venosa dextra et sinistra*.

(b) *Posterior (Dorsal) View* showing (1) dorsal ventricle incompletely divided into larger left and smaller right caval chambers, the former presenting the small posterior orifice (P.C.) of communication with the ventral ventricle, and the latter the large cleft-like anterior communication (A.C.) with this ventricle between the bulbar ridge and the anterior or left wall of the heart; (2) the auriculo-ventricular cushion which has divided the auriculo-ventricular orifice into the right and left (A.V.) openings; and (3) the orifice of communication left below this between the right and left halves of the dorsal ventricle by the growth upward of the interventricular septum (V.S.) posteriorly. (I.V.F.) Interventricular foramen. From a specimen in the Pathological Museum of McGill University, presented by Dr. C. F. Silvester, Princeton University.

III. ORDER CROCODILIA

2. *Heart of Crocodile*

Remarks: Externally there is an advance in development in the crocodile heart in that the line of junction of the ventricle may be seen passing down to the right of the gubernaculum cordis. Internally this heart carries to completion the closing of the ventricular cavæ into the two completely separated chambers of the mammal. This is accomplished by the growing out of a muscular ridge between the orifices of the right and left aortæ to fuse at right angles with the musculature of the ventricular septum of the turtle and python which remains as a small muscular band below the pulmonary orifice. This converts the *cavum venosum* and *cavum arteriosum* into perfectly distinct right and left ventricles. The right or anterior (*cavum arteriosum*) gives off the pulmonary artery and left aortic arch. The left (*cavum venosum*) is dorsal in position. The fold of the septal tip of each a.v. orifice has become a distinct membranous valve. A torsion of the truncus vessels accompanies the dorso-ventricular twisting so that the left aorta crosses to the right side and becomes the tricuspid dorsal aorta given off from the dorsal ventricle. The walls of the two aortic arches are in contact where they cross and at this point a small aperture exists above the contiguous semilunar cusps of each permitting the passage of aerated blood from the left aorta into the lumen of the right. (This is the so-called *foramen panizze* which is believed to be of secondary origin, and may be considered analagous to rupture of a congenitally thin right aortic sinus of valsalva).

NOTE.—The hearts of Crocodile and Python have been discussed at length above in relation to their bearing upon the problem of the origin of Cardiac Septal Defects.

SUMMARY

1. Certain anatomical features that have apparently become submerged in the phylogeny of the race may reappear in the human embryonic cycle, and, becoming fixed through arrest of development or other cause, persist in the adult as a "human variant."

2. In consideration of this fact, a series of gross specimens illustrating the comparative anatomy of the heart from the Teleost fish to the crocodile, has been prepared, which is described and figured in this communication.

3. These specimens present the following points of interest in the elucidation of certain cardiac anomalies as follows:

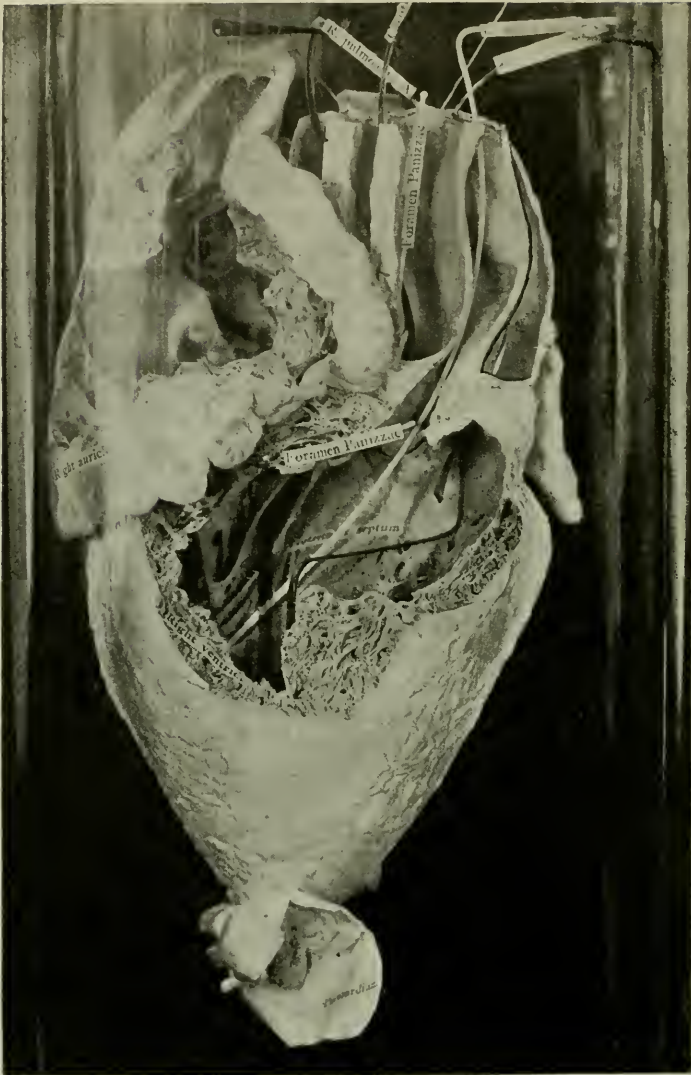


FIG. XII.

Heart of Alligator Mississippiensis.

Ventral View showing right chambers, pulmonary artery and left aortic arch (arising anteriorly from right ventricle), also right aortic arch (arising posteriorly from left ventricle and giving off the carotid arch). The foramen Panizzae lies behind the posterior cusp of the left aorta (in right ventricle) and communicates with the right aorta just behind its anterior or right coronary cusp (in left ventricle). It is marked by a white rod. The right aortic arch is marked by a dark rod. From a specimen in Professor Huntington's Anatomical Collection, Columbia University.

Reprinted from the author's article in *Contributions to Biological and Medical Research*, Paul B. Horber, 1919.

- (a) The persistent bulbus of the teleost, with constricted lower orifice *versus* certain forms of pulmonary conus stenosis (Keith ²).
- (b) The asymmetrical arrangement of the rows of valves lining the conus arteriosus of the *Lepidosteus*, the spiral grooving of the amphibian conus, and the twisted vessels of the truncus arteriosus of reptiles, mirroring the spiral endocardial swellings of the human embryo, *versus* transposition of the great trunks (Robertson ⁵).
- (c) The co-existence in the turtle and python of an anterior communication between the bulbo-ventricular ridge and the anterior wall of the ventricle uniting the dorsal and ventral ventricles (bulbar septal defect) and a second communication situate more posteriorly above the interventricular septum proper, *versus* the independent origin of defects in (1) the anterior and (2) the posterior part of the interventricular septum. (Abbott and Shanly—this article).
- 4. The *foramen panizzae* of the crocodile, *versus* ruptured (congenital) aneurysm of the right aortic sinus of valsalva (Abbott ⁹).
- 5. The large valvulae venosae of the teleost and elasmobranch fish, python and crocodile, *versus* anomalous networks in the right auricle of the adult mammalian heart.

Our thanks are expressed to Prof. Willey for the revision of the manuscript, and to Dr. W. W. Beattie for assistance in the completion of the illustrations.

MULTIPLE CARDIAC ANOMALIES; PERSISTENT
OSTIUM SECUNDUM WITH DISPLACEMENT
OF SUPERIOR VENA CAVA; PERSISTENT LEFT
DUCT OF CUVIER; DEFECT IN LOWER PART
OF VENTRICULAR SEPTUM; FUSED AORTIC
CUSPS.

HAROLD N. SEGALL

Department of Pathology, McGill University

The heart which forms the subject of this report was taken from an infant two weeks old. It was a private, outside case of Dr. W. C. Williams, to whom I am indebted for the following clinical history. The child was born at full term after a normal labour. The first cry was a feeble one and subsequent crying remained feeble. On about the 4th or 5th day after birth the voice was distinctly hoarse and remained so until death. The prenatal foetal heart beat was 120 per minute, the postnatal averaged about 110, it was regular and relatively strong. There was no evidence of cyanosis at any time. The infant weighed 7 lb., 2 oz. at birth and gained 10 oz. during the two weeks of life. Death came very suddenly and imperceptibly; while the child appeared to be sleeping, the attention of the parents was attracted by a slight blueness above the right eye and on closer examination the child was found to be dead.

At autopsy, on opening the thorax, the cardiac area controlled the field, the lungs were greatly collapsed and the trachea and bronchi markedly flattened, due to the pressure of the greatly enlarged heart. This great pressure on bronchi and trachea and no doubt also on the recurrent laryngeal nerve explains the hoarseness of the infant's voice. The greatest diameter of the cardiac area measured 7.5 cms. The long axis of the heart lay in the transverse axis of the thorax, the apex pointing to the extreme left opposite the 6th rib, near the anterior axillary line. The pericardium and pleuræ were quite normal. The pericardial cavity contained a physiological amount of clear serous fluid. On exposing the heart itself, the greatly enlarged right chambers occupied the entire anterior surface. The much smaller left chambers appeared to be only one quarter the size of the right.

On examining the vessels which enter the right auricle it is found that the inferior vena cava (I.V.C.) enters higher than is usual, its inferior arc being 1 cm. above the auriculo-ventricular

suleus. The superior vena cava, is displaced somewhat to the left and is smaller than normal. Coursing along the posterior wall of the left auricle, just above the auriculo-ventricular groove and entering the right auricle at its extreme left postero-inferior corner is an anomalous vein 3 mm. in diameter. The cavity of the right auricle is greatly dilated and its walls definitely hypertrophied measuring 2 to 3 mm. in thickness. The musculæ pectinati are thickened. Arising from the posterior and superior walls and occupying the position of the Eustachian valve is a muscular fold 2.5 cms. long, 8 mm. at its widest part, which is in the middle of third of its length, and 2 mm. thick. It begins abruptly on the posterior wall of the auricle near the margin of the atrio-ventricular canal, and terminates by spreading out into several muscoli pectinati at the antrum of the auricular appendage. This muscular fold represents the *valvula venosa dextra*, which normally forms the Eustachian and Thebesian valves. The foramen ovale is patent and relatively very large. Its long diameter which measures 1 cm. is obliquely situated so that its upper angle points posteriorly, while its lower angle points anteriorly; its greatest transverse diameter is .5 cm. The anterior border of the patent foramen ovale is formed by auricular wall and the posterior border by the thin curved margin of the *valvula foramen ovale*, a thin transparent membranous fold. This foramen ovale may be termed an *ostium secundum*, since there is no *annulus ovalis* present.

The orifice of the inferior vena cava lies immediately to the left of and is guarded by the valve-like muscular fold described above. The ostium of the superior vena cava is situated at the apex of a conical alcove, formed by the posterior wall of the auricle and a broad band of muscoli pectinate bridging the space between the auricular wall and the upper extremity of the valvular muscular fold. It rides over the auricular septal defects. A probe passed into its lumen may be directed to the right, through the alcove behind the valvular fold into the cavity of the right auricle or else towards the left, in front of the fold, through the patent foramen ovale and into the left auricle. The probe passes with greater facility along the first path than along the second. It appears, therefore, that the band of muscle stretching between the valvular fold and the auricular wall and thus forming the floor of the alcove, was developed to direct the blood from the superior vena cava into the right auricle, allowing little or no blood to pass through the foramen ovale into the left auricle.

The third large opening into the right auricle, that belonging to the vein described above as coursing along the posterior wall of

the left auricle, is situated immediately to the right of the inter-auricular septum, at the extreme left postero-inferior corner of the right auricle. This orifice is about 1.3 cms. to the left of and inferior to the ostium of the inferior vena cava. A thorough search for a coronary sinus revealed no trace of this structure at or near its normal position. Marshall, in 1850, traced the metamorphoses of the left duct of Cuvier as follows: its upper portion becomes very small and persists as one of the *venæ parvæ* which becomes embedded in the auricular wall, and is now known as the *vena Marshallii*, whilst the remaining lower portion of the ductus persists as the coronary sinus. In this case both the *vena Marshallii* and the coronary sinus are absent, it is therefore reasonable to consider this third relatively large vein, entering on the left side of the right auricle as a persistent left duct of Cuvier.

In a case reported by Schultz and quoted by M. E. Abbott,* the persistent left duct of Cuvier entered the right auricle at the normal situation of the coronary sinus, below and somewhat anterior to the orifice of the inferior vena cava.

In our case, the presence of all three ostia on the left side of the large valvular fold causes this part of the auricle to bear a definite resemblance to that stage in its development when the sinus venosus is the portal of entry for the inferior vena cava and the right and left ducts of Cuvier.

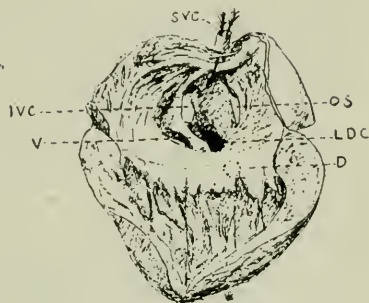
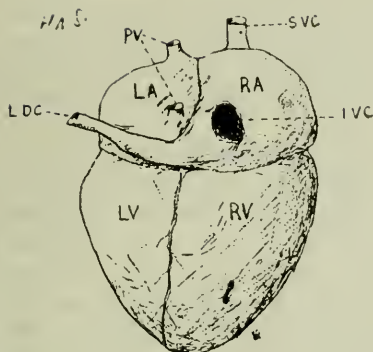
Persistence of the left duct of Cuvier is one of the commonest anomalies in the formation of the larger systemic veins. It is not infrequently found in association with other anomalies but in itself has little or no clinical significance.

The right ventricle is greatly dilated, its wall is hypertrophied being thickest near the base where the musculature is 9 mm. in thickness and becoming thinner towards the apex, where it measures 4 mm. The papillary muscles as well as the *musculi pectenati* are definitely thickened. The tricuspid valve is smooth, thin and glistening. The junctions between valve substance and *chordæ tendinæ* are relatively thickened, suggesting *fœtal endocarditis*. The valve measures 5 cms. in circumference.

The pulmonary valve shows no pathological lesions or anomalies. The valve measures 2.1 cm. in circumference. The pulmonary artery appears dilated corresponding in size to the large right chambers.

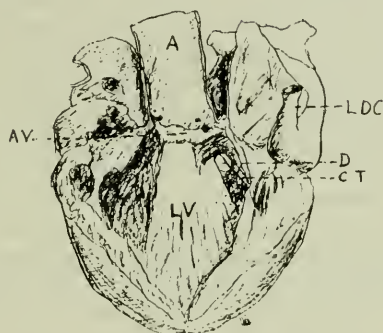
The left auricle is hypoplastic. The pulmonary veins could not all be found because a piece of left auricle was removed in taking the heart out at autopsy. The superior and inferior right

*"Congenital Cardiac Disease," by Dr. Maude E. Abbott, in Osler & MacCrea's "Modern Medicine," 2nd Edition, 1915.



EXTERNAL SURFACE, POSTERIOR ASPECT

CAVITIES OF RIGHT CHAMBERS



AORTA AND LEFT VENTRICLE LAID OPEN

Multiple Cardiac Anomalies; Persistent Ostium Secundum with Displacement of Superior Vena Cava; Persistent Left Duct of Cuvier; Defect in Lower Part of Ventricular Septum; Fused Aortic Cusps. From a Specimen in the Pathological Museum of McGill University.

SVC—Superior Vena Cava
V—Muscular Valvular Fold
LDC—Ostium of Persistent Left
Duct of Cuvier
OS—Persistent Ostium Secundum
(Foramen Ovale)
A—Aorta
AV—Aortic Valves

CT—Chordae Tendineae
IVC—Inferior Vena Cava
D—Ventricular Septal Defect
LV—Left Ventricle
PV—Pulmonary Veins
LA—Left Auricle
RV—Right Ventricle
RA—Right Auricle

pulmonary veins were found in their normal situations. The mitral valve is 2.5 cms. in circumference and shows no pathological changes. The left ventricle is also small; near the base, its musculature measures 4 mm. *i. e.* less than half that of the right ventricle at relatively the same area, towards the apex the ventricular wall gradually becomes thinner. The papillary muscles and musculi pectinati are relatively thin.

The pars membranacea septi is in its normal position. Situated 4 mm. below and somewhat posteriorly to it is a round defect in the interventricular septum measuring 7 mm. in diameter. Stretching between the superior border of this defect and the posterior papillary muscle is an aberrant chorda tendinæ measuring 12 mm. in length. Another shorter aberrant chorda only 5 mm. in length extends between the same papillary muscle and the right border of the aperture. Defects in the interventricular septum usually occur commonly in front of and just anterior to the pars membranacea septi. The interesting feature of the defect in this case is that it is situated posterior to the undefended space.

The aortic valve is not divided into three separate definite cusps but appears as a continuous fringe, presenting only one well formed raphe, the other two being very small and rudimentary. Opposite the left rudimentary raphe the valvular fringe is deeply notched. The valve substance is thin, smooth and glistening, presenting no apparent evidence of recent or old inflammation. It is, therefore, reasonable to conclude that this condition of the aortic valve is due to lack of proper development. It measures 1.1 cms. in circumference: The aorta itself is much smaller than the pulmonary artery and corresponds in its size to the smaller left chambers. The right and left coronary orifices are in their normal positions. In the region of the sinuses of valsalva the aorta appears distended by one continuous dilatation.

No lesions of any consequence were found in the other organs of the body.

None of the anomalies alone or together are sufficient to account for the death of the child. The great size of the right heart may be accounted for by a possible entrance of some of the pulmonary veins into the persistent left duct of Cuvier, thus, oxygenated blood which should go to the left auricle, mixed with the venous blood in the right auricle and also increased the bulk of blood which passed the right chambers. This condition might have led to a limit of dilatation of the right side, followed by its paralysis and death of the child.

It is possible also that the greatly enlarged heart, big enough to flatten the trachea and bronchi into ribbon-like structures,

could have pressed on the phrenic nerve to cause paralysis of the diaphragm and so a respiratory death. This is improbable from the quietness of the death.

Frequently children die suddenly and imperceptibly, just as this infant did, and at autopsy, no cause of death can be found, and basing his opinion on a thymus which is somewhat enlarged, "status lymphaticus" becomes the protocol diagnosis of the pathologist. Our case may belong to this category.

My thanks are due to Dr. Maude E. Abbott for her assistance in the preparation of this report.

CARDIAC ANOMALY (BICAMERAL HEART) IN SITUS INVERSUS

MIRROR-PICTURE TRANSPOSITION OF VENTRICLES, AORTA, AND PULMONARY ARTERY. REVERSED INSERTION OF AORTA AND PULMONARY ARTERY. AURICLES NOT TRANSPOSED. SUPERIOR AND INFERIOR VENAE CAVAE OPEN IN COMMON. PERSISTENT LEFT DUCTUS CUVIERII. PERSISTENT OSTIUM PRIMUM. COMMON AURICULO-VENTRICULAR ORIFICE. VENTRICULAR SEPTAL DEFECT. ATRESIA OF REVERSED PULMONARY ARTERY. PATENT RIGHT DUCTUS ARTERIOSUS.

Associated with

ATRESIA OF MIDDLE OF OESOPHAGUS AND COMMUNICATION OF UPPER END OF LOWER FRAGMENT WITH TRACHEA.

W. W. BEATTIE, B.A., M.D.

*Assistant Curator, Pathological Museum, McGill University
Montreal*

The heart that forms the subject of the following report was presented to the medical museum of McGill University by Dr. Paul G. Woolley, of Detroit, Mich., and was studied under the direction, and with the help of, the Curator, Dr. Maude E. Abbott, to whom the writer's thanks are due.

The case was a blue baby with situs inversus viscerum. It died with what appeared to be an acute catarrhal bronchitis without any pulmonary consolidation.

EXAMINATION OF THE HEART

The heart is about equal in size to that of a normal child of the same age. The ventricles form a mirror-picture of the normal, *i. e.*, the apex points to the right and is formed by the transposed left (mitral) ventricle, while the transposed right (tricuspid) ventricle is recognized by its prominent conus, which gives off a large vessel in the situation that would be occupied by the pulmonary artery in mirror-picture transposition. However, upon further examination this vessel is seen to be the aorta and not the pulmonary artery. It gives off a coronary artery from an anterior sinus of Valsalva, which passes to the left giving off an anterior interventricular branch, and another coronary artery from a right posterior sinus of Valsalva, which passes to the left and ends as a posterior interventricular branch. The aorta curves upwards, and to the right, thus forming a right aortic arch which gives off from its anterior superior aspect an innominate and a left common carotid artery, from a single orifice, and a left subclavian artery, in that order from right to left.

The pulmonary artery occupies the position in which the aorta would be situated in a mirror-picture transposition, *i. e.*, arising from the transposed left (mitral) ventricle behind the aorta, and slightly to the right. It is, however, completely atresic below, the lumen having no communication with that of the ventricle. It divides into left and right branches, the former passing behind the aorta, the latter communicating with the aorta by a widely patent (4 mm. in diameter) ductus arteriosus opposite the common origin of the right innominate and left common carotid arteries.

The right aortic arch, with its branches, and the ductus arteriosus arising from the right pulmonary artery thus represent a mirror-picture transposition; but besides this, it is evident that there is a reversed insertion of the arterial trunks, the aorta arising from the transposed right (tricuspid) ventricle and the pulmonary artery from the transposed left (mitral) ventricle.

The auricles are not transposed. The superior and the inferior venæ cavæ unite to form a short, thick vessel which opens into the postero-superior aspect of the right auricle. (The inferior venæ cavæ ascends to the right side of the descending right aortic arch). At the site usually occupied by the coronary sinus a vessel of about the size of the superior vena cava enters and receives just at its entrance several cardiac veins. This vessel represents a persistent left ductus Cuvierii. The pulmonary veins enter the left auricle, either as a single trunk, or the right form the single

trunk and the left are represented by two tubercles, which are not cannalized, situated a little to the left of the common trunk. (The pulmonary veins are cut off so close to the auricle that their exact relations cannot be determined).

On opening the heart there is found to be a wide communication between the two sides and a common auriculo-ventricular orifice. A septum hangs down from the postero-superior wall of the auricular cavity about half way to the auriculo-ventricular orifice. This septum is thin and translucent above and posteriorly, not fenestrated however, and has a thick, rounded, slightly sickle-shaped lower free border. It is the septum primum and the communication between the right and the left auricles below it, is the persistent ostium primum. The orifice of the coronary sinus, or rather of the left ductus Cuvierii, is situated below and slightly to the left of the lower free border of the septum primum. Its left margin is produced into a very prominent valve-like fold, which would probably serve to direct the blood into the right auricle through the ostium primum, and which probably represents a part of the *valvula venosæ sinistra*. The Eustachian and Thebisian valves which represent the *valvula venosæ dextra* are not distinguishable.

The interventricular septum is defective above posteriorly having a free, rounded, crescentic upper border below the common auriculo-ventricular orifice. This latter orifice is guarded by an anterior and posterior valve cusp, both of which are continuous over the free upper border of the interventricular septum from one ventricle to the other, and are attached to the walls of both by *cordæ tendiniæ* inserted into papillary muscles.

The cavity of the transposed right (tricuspid) ventricle is normal, except for the septal defect, but as a mirror-picture, showing coarse *trabeculæ carneæ* and a well-defined *conus* demarcated by a moderator band and a *crista supra ventricularis*, from which in the site usually occupied by the pulmonary artery, the aorta arises, with an orifice guarded by a tricuspid semilunar valve with one anterior and two posterior cusps.

The cavity of the transposed left (mitral) ventricle is lined by fine *trabeculæ carneæ* and is a mirror-picture of the normal except for the septal defect, but no communication with the lumen of the pulmonary artery is present; it ends blindly at the site of the usual origin of the aorta.

Attached to the superior dorsal wall of the auricles is a portion of the trachea and oesophagus comprising the bifurcation of the latter and two centimeters above. The oesophagus is divided into two portions; the upper portion ends blindly one

centimeter above the bifurcation of the trachea; the lower portion communicates by its upper end with the trachea, one centimeter above the bifurcation by a circular orifice 4 mm. in diameter. Thus, no food could enter the stomach except by traversing the glottis and upper portion of the trachea. In such an event some would be sure to run down into the bronchi and would give rise to symptoms resembling acute catarrhal bronchitis.

ANATOMICAL SUMMARY

1. Mirror-picture transposition of ventricles.
2. Auricles not transposed.
3. Right aortic arch and right ductus arteriosus (part of situs inversus).
4. Reversed insertion of arterial trunks.
5. Superior and inferior venæ cavæ unite to form short thick vessel before entering right auricle. (Persistence of part of sinus venosus).
6. Persistent left ductus Cuvierii.
7. Atresia of orifice of the reversely inserted pulmonary artery.
8. Large defect in lower part of auricular septum. (Persistent ostium primum).
9. Large defect in posterior and upper part of ventricular septum.
10. Single auriculo-ventricular orifice guarded by a large anterior and a large posterior cusp which extend across from one ventricle to the other over the free upper border of the inter-ventricular defects.
11. Atresia of middle of œsophagus, upper portion ending blindly below and lower portion communicating at its upper end with the trachea, one centimeter above bifurcation.

DISCUSSION

The reversed insertion of the arterial trunks, coupled with a mirror-picture transposition of the ventricles, while the auricles are not transposed, forms an arrangement which if the other serious anomalies, *i. e.*, pulmonary stenosis and septal defect, were not present would seem to be compatible with normal life. In such a case the blood from the systemic veins would enter the not transposed right auricle, and then be pumped into the transposed left (mitral) ventricle, and from there would enter the reversed pulmonary artery. The blood from the lungs would enter the not

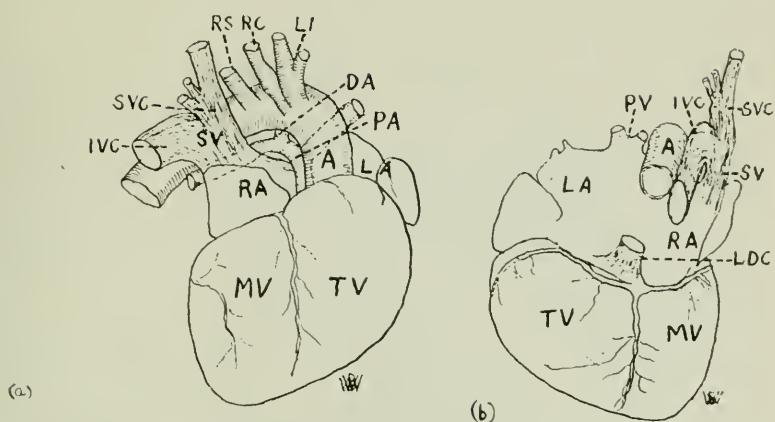


FIG. I.—EXTERNAL VIEW OF HEART (a) VENTRAL SURFACE
(b) DORSAL SURFACE

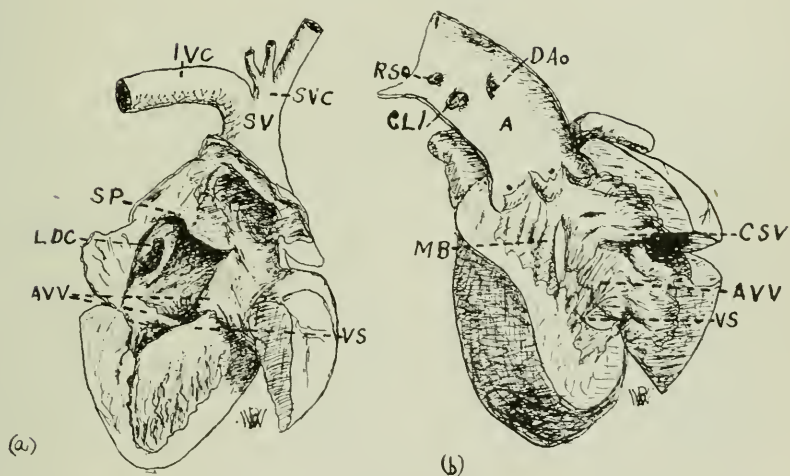


FIG. II.—HEART LAID OPEN (a) TO EXPOSE TRANSPOSED MITRAL VENTRICLE
(b) TO EXPOSE TRANSPOSED TRICUSPID VENTRICLE

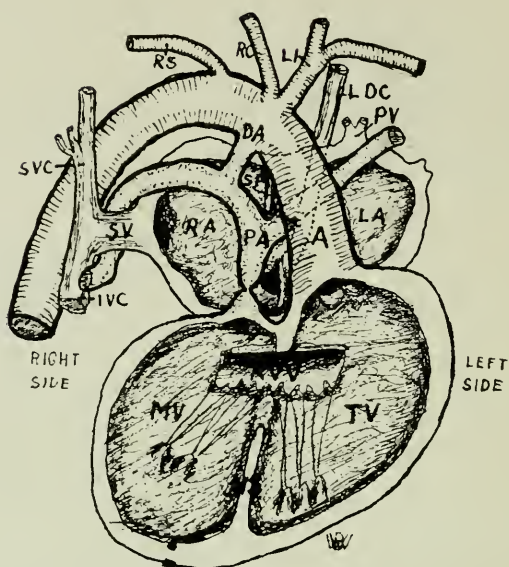


FIG. III.—DIAGRAMATIC VIEW OF HEART WITH VENTRAL WALLS OF AURICLE AND VENTRICLES CUT AWAY.

MV—Transposed Mitral Ventricle
 TV—“ Tripuspid “
 RA—Right Auricle not transposed
 LA—Left “ “
 A—Reversely Inserted Aorta with
 Right Aortic Arch
 PA—Reversely Inserted Pul-
 monary Artery
 DA—Right Ductus Arteriosus
 LI—Left Innominate Artery
 RC—Right Common Carotid Artery
 RS—“ Subclavian “
 SV—Persistent Part of Sinus
 Venosus
 SVC—Superior Vena Cava
 DAO—Orifice of Right Ductus
 Arteriosus

IVC—Inferior Vena Cava
 PV—Pulmonary Veins
 LDC—Persistent Left Ductus Cuvierii
 SP—Free Lower Border of Septum
 Primum
 AVV—Anterior and Posterior Cusps
 of Common Auriculo-Ventricular
 Valve
 VS—Free Upper Border of Ventricular
 Septum
 CSV—Crista Supra Ventricularis
 RSO—Orifice of Right Subclavian
 Artery
 CLI—Common Orifice of Left In-
 nominate and Right Common
 Carotid
 MB—Moderator Band

CARDIAC ANOMALY (BICAMERAL HEART) IN SITUS INVERSUS. *From a Specimen in the Pathological Museum, McGill University, presented by Dr. P. G. Woolley. W. W. Beattie.*

transposed left auricle and then be pumped into the transposed right (tricuspid) ventricle, and from there would enter the aorta.

With the atresia of the orifice of the pulmonary artery and the large septal defects, however, there must have been complete mixing of oxygenated and deoxygenated blood, and in order to reach the lung, the only course which this mixed blood could take was through the patent ductus arteriosus. These two facts, admixture of streams and pulmonary atresia, were evidently the cause of the cyanosis noted clinically; whether they would in themselves, without the obstruction to the bronchi due to the œsophageal anomaly, have led to such an early death, is doubtful.

The anomaly of the œsophagus is a common and well recognized one and is described by Frederick T. Lewis in Keibel and Mall's *Manual of Human Embryology*, pages 312 and 313, where it is stated that it must arise in embryos of about 4 mm., which is probably about the time that the arrest in development occurred which led to the persistent ostium primum, single auriculo-ventricular orifice, and ventricular septal defect, so that we can probably conclude that all were due to the same cause.

ABSTRACTS OF CURRENT LITERATURE

By M. E. ABBOTT, M.D., *McGill University, Montreal*
and

EDNA G. DYAR, *St. Elizabeth Hospital, Washington, D. C.*

MICROSCOPIC TECHNIQUE

Experimental Pigment Cirrhosis due to Copper and its Relation to Hæmochromatosis, with description of Technical Methods employed:

MALLORY, PARKER and NYE of the Boston City Hospital (*Jour. Med. Res.*, 1921, *xlii* 461-490) have made an important contribution to the literature in a valuable experimental and histologic study of the micro-chemical diagnostic methods, primary cell lesion, histogenesis, and pathogenesis, of the obscure disease known as Hæmochromatosis, a condition which is characterized by the presence in large amount in the cells of the body tissues of iron-containing pigment derived from hæmoglobin, which exists in part: (a) in the primary form of hæmofuscin in close combination with the cell protoplasm as golden brown granules, staining deeply with aniline dyes, but giving no reaction for iron with the ordinary reagents; and in part, has undergone metabolic changes which have thrown it (b) into a more loosely united compound (hæmosiderin) which reacts readily to the ordinary microchemical tests for iron through transformation into the ferrous or the ferric salt according to the test employed. On the basis of experimental results obtained on rabbits the suggestion is advanced by the authors that Hæmochromatosis may be due to copper poisoning. The fundamental value of this communication rests not only upon the new path for investigation thus opened, but also in the illumination which is thrown, by the admirable technical methods employed, upon the subject of the differentiation of the two iron-containing pigments, the primary nature of the hæmofuscin and the secondary origin from it of the hæmosiderin, and the successive steps in the evolution of the pigment cirrhosis through intracellular formation and distribution of pigment, parenchymatous cell necrosis, endothelial invasion of dying pigmented cells, and sclerosis, to the final condition.

In the description of the technical procedures followed (to which six full pages are devoted), one of the most important points made is the solution of the difficulty experienced by all workers on this subject in obtaining a uniform bright Berlin-blue reaction from hæmosiderin by the application of Perl's test for iron. The brilliant blue colour of the ferric salt is obtained in all specimens containing hæmosiderin, even those which have been long preserved in formalin, by increasing the amount of dilute hydrochloric acid employed from equal parts, as prescribed in Perl's test, to the proportion of three parts of 1 per cent. solution of hydrochloric acid to two parts of 2 per cent. solution of ferrocyanide of potassium; fixation is made in alcohol or formalin and not in Zenker, which renders the stain soluble; the reaction is hastened by warming the mixture of the two solutions, and counterstaining is done with alum carmine or one per cent. safranin, and not with lithium carmine. The other diagnostic stains employed are the ammonium sulphide test, and the so-called Turnbull's blue, which presents results

from the action of ferricyanide and hydrochloric acid on a ferrous salt. To stain hæmofuscin granules paraffin sections are used, the nuclei stained with alum hæmatoxylin and then after washing stained for ten to thirty minutes in an alcoholic solution of fuchsin (.5 gm in alcohol 95 per cent. cc., and Water 50 cc.). When it is desired to stain both hæmofuscin and hæmosiderin in the same section the preliminary staining with alum hæmatoxylin is omitted and the fuchsin followed by the reagents of Perl's test in a mixture modified as above stated. Workers in this field must consult the article itself for more exact details of the various technical procedures followed, which are given there in full and with great clarity.

On the Value of the Nile-Blue Method for the Exhibition of Fatty Substances and on the Influence of Long Formalin Fixation on the Disappearance of Colors:

BOEMINGHAYS (*Zeit. Beitr. z. Path. Anat.*, 1920, lxxii, 533) observed in fat embolism of the lung stained by Nile-blue sulphate that the original bright red staining was replaced by a bright blue with the same stain in sections taken from the same block of tissue after this had lain several years in a 4 per cent. solution of formalin. He therefore investigated the metachromatic property of Nile-blue sulphate on the various fatty acids and their esters, as well as on pieces from the principal fat depots of the body, and also the effect of prolonged preservation in formalin on the properties of this stain. The fatty substances were dissolved in ether or benzol, etc. and after evaporation a drop was spread in a thin layer on a slide and stained ten minutes in concentrated watery solution of Nile-blue sulphate. Triolein and fat from bone marrow, renal capsule and mesentery and subcutaneous and epicardial fat (which contain Triolein) stained a brilliant red, oleic acid bright blue; other fatty acids and esters and their combinations slight blue or not at all. He concluded that the affinity of Nile-blue for fatty substances other than oleic acid and its derivatives is not great, and explains the brilliant staining properties of the latter with Nile-blue by the fact that they are compounds with certain chemical affinities not satisfied.

The effect of prolonged preservation in formalin was tested (1) by placing material, which has first stained bright red, in the incubator; in a few days the colour had changed at the border of the fat particles from red to blue, later the entire section became blue; (2) specimens staining red at first with Nile-blue changed to blue after one and a half months' preservation in formalin solution. The explanation of this alteration in staining reaction is that fats are split up by formic acid which becomes free in the formalin solution.

On the Chemistry of Microscopic Stains:

O. KESTNER (*Arch. Derm. und Syph.*, 1921, 130, 472) found that if masses of fibrin which had been washed out and treated in a reagent glass, some with acids others with alkalis were placed in a weak solution of the ordinary histological stains, the intensity and kind of staining varied, depending upon both the chemical nature of the stain used, and also upon the character of albumen in the fibrinous mass. Three types of staining reactions were to be distinguished: (1) Absorption which produces only weak and diffuse stains such as eosin; (2) Chemical reactions, in which the molecular colours dissolve and form coloured compounds with the albumen of the cells, as in methylen blue; (3) A reaction between colloid bodies which differs from chemical salt formation and is often opposed to this. To the latter belong such stains as neutral red, congo red and alizarin red.

On a New Method of Staining Blood and Blood Parasites:

EPSTEIN (*Centralbl. f. Bak. Parasit. u. Inf.*, April 13th, 1922) experi-

mented with an aqueous solution of Toluidin-blue and found that its metachromatic properties were increased by the addition of alkali, but that excess of alkali darkened the stain, making it unfit for blood work. These difficulties were overcome by combining with lithium citrate (1 gram to 1,000 cc. distilled water and 1 gram Toluidin-blue); a colloidal precipitate results which is filtered off, leaving the stain (solution A) ready for use. Coverslip smears are placed in it for 10-30 minutes, then washed in running water, placed for 1-3 seconds in cold salinated watery solution of picric acid (solution B), washed thoroughly again and dried with blotting paper (not heated). A one per cent. solution of lithium oxalate or citrate may be substituted for the citrate. Beautifully clean and clear blood pictures result, normocytes brilliant green, polychromatophiles bluish green with dark blue stippling; nuclei red-violet; polymorph leucocytes have protoplasm bluish gray, neutrophile granules violet, eosinophile brilliant green blue. Alcohol or heat removes the red colour from the slide, but metachromatic properties of the stain are restored by adding water again.

Comparative Staining of Living and Dead Bacteria:

SEIFFERT (*Centrbl. fur Path., April 13th, 1922*) experimented to find a stain which would not penetrate the capsules of living bacteria and would thus differentiate these in the hanging drop from dead bacteria into which such stain would readily penetrate. The impetus to this investigation was given by the observation that when a protein is combined with such stains as anilin gentian-violet, the molecule is so large that it will not stain living bacteria, while dead ones are brilliantly coloured, but the result is vitiated by the fact that all the stain does not combine with the protein and some remains free and stains isolated bacteria. Constant differentiation was obtained with congo-red dissolved to saturation in physiological salt solution and diluted 1 in 10 with the same medium. Colouration of the field was very dark, so that the organisms must be examined one by one at border of drop. The method is not of use to prove sterility but to determine if atypical vibrios in culture are alive or dead.

Bioscopic Method for Determination of the Vitality of Tumour Tissue in Vitro and Effect of Irradiation on Vitality of Tumour:

KURT WEISE (*Centr. bl. f. Bakt. Par. u. Inf., April 13th, 1922*) successfully applied Gösius' observation that living bacteria in a clear watery solution of potassium telluride (*Kalium tellurosium*) causes a black precipitate of metallic tellurium with the bodies of the dead bacteria, to establish a bioscopic proof of the vitality of tumour tissue. To this end he places 0.2 gm. pieces of living mouse tumour in a reagent glass with 5 cc. of 1-10,000 solution of potassium telluride in physiological saline. A black precipitate results which shows as black discoloration of the tissue surface, and completely infiltrates this in 24 hours. Dead (boiled) tissue from the same block remained unchanged in the telluride. A radiated tissue from the same block of living tissue gave the same black precipitate as before radiation.

Hydrogen-ion Concentration of Tissue Growth in Vitro:

M. R. LEWIS and L. D. FELTON (*Johns Hop. Bull., Mar., 1922*) determined the optimum H-ion concentration for tissue cultures of ex-plants from chick embryos of 7-9 days' incubation in Locke-Lewis solution to be 6.8 to 7.00 pH, and that the most favorable was one to which 0.5 to 1 per cent. of dextrose had been added. The pH was reduced below 6.8 if the dextrose was increased and rose to as much as 9.00 pH in the absence of dextrose. In making Felton's colorimetric test (*Jour. Biol. Chem. 1921, xlv, 299*), it was noted that many coverslips gave an alkaline reaction and that all coverslips should be kept in dilute

sulphuric acid for 24 hours and then tested before using and unreliable ones rejected.

Microscopic Study of the Sinuventricular Bundle, Especially as a Source of Replacement of Degenerating Myocardium:

LEE D. CADY (*Anat. Rec., July 20th, 1921*) undertook this study with a view to testing the conclusion by Retzer that worn out myocardium is replaced by new myocardium derived from the Purkinje fibres of the Sinoventricular system. He concluded that there is no adequate histological evidence of this. For longitudinal sections, the adult heart was laid open by a vertical incision through the back of the right auricle and ventricle to the apex; the walls of both chambers everted and the whole heart flattened against a clean glass slide, lightly weighted down and covered with Zenker-formol fixing fluid. A one-week old heart was hardened in 95 per cent. alcohol and sectioned transversely and serially stained with hematoxylin and eosin; and the atrial septum of a young adult similarly fixed and stained, was sectioned longitudinally from the endocardial surface of the left atrium (to show nodal tissue); blocks of septum and of ventricle wall were sectioned transversely and longitudinally (to get transition fibres); all sections were mounted serially five or six to the slide and alternate slides stained with H and E, and with special stains, including Mallory's phosphotungstic acid hematoxylin. Silver impregnation methods were used and staining with hemalaun after Zimmerman's fixation for intercalated discs.

Differential Staining of Preserved Specimens of Bone:

BATSON (*Anat. Rec., Oct., 1921*) has investigated the value of various alizarin derivatives and mordant dyes in the counterstaining of bone which had been colored *intra vitam* by the well-known laboratory methods. Such colouration of bone was done as early as 1581 A.D. The dye used was that of the madder root, the active staining principles of which are alizarin and purpurin. In this investigation, portions of pig embryo 3.5 cms. to 8 cms. in size were fixed in 10 per cent. formalin and bleached in $\frac{1}{2}$ per cent. solution of the stain under investigation, then differentiated in a $\frac{1}{2}$ per cent. solution of sulphuric acid, dehydrated and cleared after the method of Spalteholz. Twelve stains were so investigated. Of these, indigo carmine and Bordeaux-red (Grubler), Alizarol-black 3G (National Aniline & Chemical Co., New York) and Alizar-black SBB (Bayer) were found especially suitable for staining preserved specimens of bone. The anthraquinone grouping was found to be unnecessary for bone staining.

Sandpaper in Preparation of Ground Sections of Hard Substances:

FANZ (*Anat. Rec., July, 1918*) recommends the introduction of sandpaper in ground section technique, claiming that it saves much time and annoyance. He uses different grades of sandpaper of a kind (flint, emery, etc.) suited to the hardness of the material. A "coarse section" is cut as thin as possible, with a jeweller's saw from a characteristic part of the surface to be examined, and is firmly cemented to the outer third of the upper surface of a thick microscopic slide with hot orange shellac which has been carefully warmed up to, but not beyond, its heating point and which is applied around but not under the section. In grinding and polishing the slide is placed face downward on the sandpaper and moved with the finger elliptically with quick, easy swing. After completion the section is removed with alcohol, inverted, recemented, and its second surface ground and polished. Great care is required to avoid breakage in the later stages. Alcohol stains may be applied direct or aqueous stains after dealcoholization of the section.

Studies on Bone Cells Facilitated by a New Technique:

T. H. BLAST (*Anat. Rec.*, July 15th, 1921) finds that thin spicules and laminae of bone may be studied microscopically even under the immersion lens, without decalcification, with satisfactory results, by fixation of very thin pieces in 95 per cent. alcohol, washing in water and then staining for 8-24 hours in a dilute aqueous solution of gentian violet. The bone cells are stained intensely while the matrix remains unstained. The pieces are rapidly dehydrated in successive strengths of alcohol and cleared in benzol. All periosteum is carefully scraped off under a binocular microscope. Mount in balsam. The advantage of this method is that bone cells can be studied without the distorting effect of acids.

Trypan Blue Injection into Developing Egg of Hen:

WISLOCKI (*Anat. Rec.*, Nov. 20th, 1921) made a successful investigation into the fate of dyes in the developing egg by the injection at different regions of Trypan Blue, 0.2 cc. of a one per cent. solution in sterile distilled water was inserted with a 26 gauge needle one inch in length, into each egg, through a small nick in the shell, which was closed with paraffin immediately after the injection. Five dozen eggs containing chicks of eleven days' incubation were so injected and killed on the thirteenth day. To inject the eggs in different regions, the embryo was allowed to float on the upper surface of the egg by a few hours' rest in the incubator, the position of the foetal membranes so gauged and the needle was inserted more or less deeply into different locations, according to the chamber sought. *In injection into the Air Chamber*, the dye was rapidly absorbed by the shell membrane turning it a deep blue; *into the yoke sac* a greenish blue discolouration of its wall ensued, due to absorption by endodermal epithelium, especially in region of the area vasculosa. The dye did not penetrate the vitelline vessels or stain the embryo. *Into Allantoic Sac*, fluid was coloured deep blue, but the dye did not penetrate its wall or escape from its cavity (excretory function only). *Into Amniotic Sac*, dye mixed freely with fluid and penetrated lining cells as fine blue dust, stomach and intestine contained particles (evidencing swallowing), and entire embryo took a pale blue tinge. *Into Mesoblast of Allantois* (rich in embryonic blood vessels). *Vital staining* of embryo ensured all tissues except central nervous system presenting a blue aspect. Granules were most abundant in the Wolffian bodies and liver. Also marked in metanephros, arteries and spleen. Granules microscopically in all these organs.

Wax-Plate Reconstruction:

METCALF (*Anat. Rec.*, June 20th 1921) adds the following technical points to the communication by Lewis (*Anat. Rec.*, Sept., 1915). *Bromide paper negatives* may be recommended instead of positive prints from glass negatives as being cheaper, easier to use and store, and more direct; other paper negatives are not so satisfactory. *Wax sheets* similar to the plates used for reconstruction, which are laborious to make and expensive to buy, are smoothed out in the process of making comb honey and may be purchased from the foundation manufacturer for almost as low a price as the raw beeswax. He has obtained plates 12 by 12 inches and in three thicknesses, "Sheetter-wax" 2.15 mm., "broader sheets" 7.23 and "plain sheets" 4 mm. thick. In using these sheets for reconstruction it is of course necessary to grade the magnification to the thickness of plates by the simple calculation:

$$\frac{1000}{\text{Thickness of section}} \times \text{thickness of plate} = \text{magnification required.}$$

Handling Small Objects in Making Microscopic Preparations:

CHAS. W. METZ (*Anat. Rec.*, July 20th, 1921) records a simple and satisfactory method of handling very small objects as the gonads

of flies for cytological study. The thin skin surrounding the abdomen of the pupæ of the banana fly (*drosophila*) under its chitinous case is obtained by cutting the pupæ in two across the thorax, removing the posterior wall of case and extracting contents of abdomen under water. The skin forms an ovoid transparent bag with slightly constricted opening at its anterior end (between abdomen and thorax) through which the eggs or other small objects are passed and securely packed. The opening is closed by twisting the edges and immersing in fixative or alcohol. Dehydrating and embedding may then be safely proceeded with, without loss of contents. The method is cleanly, convenient and accurate, the uniform size of the bag and its transparency permitting standardization and orientation of its contents. Pupæ may be obtained as required by enclosing a few flies in a bottle with ripe banana and a piece of paper.

M. E. A.

Gold Chloride and Sublimate Staining Method for Neuroglia Cells:

ROMON Y. CAJAL (*Trab. Lab. Invest. Biol., Madrid, xl, 1913*, pp. 219 and 255, 1916, p. 155; *The Microtomists Vade-Mecum*, A. B. Lee, 8th Edition), states that the above is an excellent stain for Cajal's pleurigenic plexus which forms the bulk of the protoplasmic neuroglia in the human cerebral cortex and for the astrocytes which make up the bulk of the fibrous neuroglia in the white matter of the central nervous system. The other protoplasmic elements may be stained by his uranium nitrate method or by other cytological methods.

A Differential Stain for Nerve Fibres:

HELENOR CAMPBELL, *Microscopist, Army Medical Museum, Washington, D.C.*, (Military Surgeon, July, 1922), gives a silver impregnation method with Carnoy fixation for medullated fibres which has the advantage of allowing for a counterstain for differentiation of other tissue elements. Nerve cells stain brown, all nuclei blue, medullated fibres brownish black; non-medullated black; medullary sheath, yellow; and other tissues distinctly, while those remaining unaffected by the silver impregnation retain their acid-ophilic properties and stain pink.

The Technique of Making and Staining Frozen Sections:

J. HARPER, *Lieutenant Commander, Medical Corps, U. S. Navy* (*U. S. Naval Medical Bull.*, vol. vi, No. 3, March, 1922), gives rapid methods for frozen sections on fresh and formalin fixed material. The technique of Wilson (as used at the Mayo Foundation) with dextrine solution and the method used at the Naval Medical School, are given in detail.

Staining of Gram-Negative Bacilli:

W. G. MACCALLUM (*Jour. Am. Med. Assoc.*, 1919, 72, 193) used Goodpasture's acid fuchsin and counterstaining by saturated aqueous picric acid, followed by Stirling's gentian violet and Gram's iodine. Gram-negative organisms stain red, Gram-positive blue and the tissues stain brilliantly in shades of red or blue.

Staining of Spirochæta Pallida by Aceton Silver Impregnation Method:

HAYTHORNE (*Jour. Am. Med. Assoc.*, 1921, 76-725) obtained beautiful differentiation by a method described in detail here. In specimens containing great numbers of spirochætes 1 per cent. silver nitrate was used in the first solution, but for diagnosis of unknown specimens 2.5 per cent. solution in distilled water gave the more reliable results.

E. D.

MACROSCOPIC TECHNIQUE: COLOUR PRESERVATION, GROSS STAINING, METHODS OF MOUNTING AND PRESERVATION OF MATERIAL

Restoring Mummified Anatomical Material:

BATSON (*Anat. Rec.*, Oct. 20th, 1921) restores hardened extremities and other parts of dissecting room subjects by injecting under massage by a 25-50 cc. barrel syringe a fluid containing 5 grams. of gum tragacanth to 100 cc. of glycerine and a litre of water.

Demonstration of Cartilaginous Skeleton in Mammalian Embryo:

C. H. MILLER (*Anat. Rec.*, March 20th, 1922) uses toluidin blue stain recommended by Lundvall and the potassium hydroxide clearing method of Schultze with uniformly good results, and finds it a simple and inexpensive procedure; most of the fetuses had been fixed in 10 per cent. alcohol. The successive steps in the technique are described.

Transparent Museum Preparations:

CROCKER (*N. Y. Path. Soc.*, April 13th, 1916) showed a pig embryo made transparent by the method of Spalteholz, and referred his hearers for the technique to the second edition of the book by Dr. Werner Spalteholz, *Über das Sichtigmachen von Präparaten*, G. E. Stechert and Co., 129 W 20th Street, New York.

Mounting Museum Specimens under Watch-Glass:

L. ENOS (*Chicago Pathological Society*, Feb. 19th, 1914) describes in detail the method of mounting thin slices of pathological material preserved in Kaiserling in this fluid under large watch glasses which are cemented to a plate glass mount, all bubbles having been expelled, the lower plate being then enclosed in a cardboard mount. This method was perfected in Germany, but its technique was not revealed, and was worked out independently by the writer. The Kaiserling preserving fluid should be boiled five or six minutes before using. (The technique of this procedure, known in Germany as the Buchholz method, was also worked out independently by Dr. W. Hutchinson and Mr. E. L. Judah in the year 1911, and published by them in Bulletin IV of the International Association of Medical Museums.—Ed.).

Mounting Flat Specimens in Gelatin between Glass Plates:

SHORE (*Jour. Path. and Bact.*, April, 1921) devised this method simultaneously with Kelley Hale (see below), but independently, in the summer of 1919, to meet the post-war conditions of high cost of material and lack of glass museum jars. In his technique, small specimens or slices of larger ones are used, preferably preserved by the Kaiserling method with the following modifications: (1) the first solution is made with 10 per cent. formalin which has been rendered neutral to litmus by caustic soda, thus neutralizing the formic acid that is invariably present and that seriously interferes with colour preservation; (2) in the final solution the potassium acetate is omitted and the glycerine is increased to 40-50 per cent. The mounting chamber is made on an oblong glass base with ground edges, cut from thick window glass to standard size 6 by 3½ in.; on this a chamber 3½ by 3½ in., or 4½ by 3½ in. is built up with lengths of glass rod of uniform bore, and a cover of the required size for which lantern-slide or quarter-photographic plate glasses were used. In its construction the chamber is outlined on the middle of the plate with white enamel which is then baked several hours in the paraffin at 55° C. The four rods are attached over this outline by the same enamel and the mount is then also stoved until the

chamber so made is secure. At the same time the border of the cover is painted $\frac{3}{8}$ to $\frac{1}{4}$ in. deep to conceal the glass rod below it, to which it is cemented when the mounting is completed with a specially devised cement made of white lead and gold size. A 10 per cent gelatin solution cleared with white of egg is made up with 20 per cent. of glycerine and the chamber half filled, the specimen laid in from above carefully, covered with gelatin and allowed to set; when the surface is painted with formalin to fix the gelatin; more gelatin is added to exclude air space and the cover applied.

In KELLY HALE's method (*Jour. Am. Med. Assoc.*, Sept. 6th, 1919) the plates are separated by strips of glass of any required thickness cut with square ends and are attached with Canada Balsam, and the cover is applied before the specimen, which is introduced through one side of the chamber left free for the purpose, the glass being kept in warm water to keep the gelatin liquid meantime.

Such specimens can be filed like lantern slides, used for projection, and at the bedside.

The Glycerin-Gelatin Picture-Frame Method:

C. C. SPEIDEL and ROY M. HOOVER (*Anat. Rec.*, Dec. 20th, 1921) employ a somewhat similar technique to the above on a larger scale. They injected the body of an infant with carmine gelatin by femoral artery and fixed in a jar of full strength formalin, first injecting the body cavities also. The body was sectioned two days later in a mitre box with a sharp knife, cross slices half an inch thick being made. Special frames of fine wood were made with glass plates fitted in groove to form floor and roof of chamber, the latter added after gelatin and the cross section imbedded in it had been introduced. The frames were nailed together and sealed with paraffin.

M. E. A.

TEACHING AND FILING FIXTURES

Stereoscopic Cabinet for Demonstration of Anatomical and Pathological Specimens:

A. GIBSON (*Jour. Am. Med. Assoc.*, Aug. 21st, 1920) has devised a convenient demonstration cabinet for the serial arrangement and preservation of stereoscopic views, which retains them in logical sequence and prevents destruction. The views are mounted in sets of sixty on an endless chain on a framework which fits into a cabinet containing an adjustable face piece which carries a number of stereoscopic lenses. The chain is turned by a handle. Within and at the top of the cabinet is a long, narrow electric globe for night illumination.

Display and Storage of Anatomical Charts:

NICHOLSON (*Anat. Rec.*, Aug. 20th, 1921) points out that the value of large anatomical charts is greatly enhanced by mounting in serial order easily accessible to the student and demonstrator. Each chart is mounted on a light wooden frame and swung by a double hinge along the wall to which it is attached along 2 by 4 inch wooden bars. The frames are firmly secured at the corners and are separated by a diagonal base. The hinge has a long shank and is in two parts, so that the frames with attached charts can readily be removed and replaced or filed in storage while another series is in use.

Filing Slides from Necropsy Sections and for Demonstrations:

W. L. ROBINSON (*Jour. Am. Med. Assoc.*, Dec. 15th, 1917) files microscopical slides in series of 12 in a manilla folder in an ordinary cabinet.

A folder $9\frac{1}{2}$ in. square is used; one edge is turned up $1\frac{3}{4}$ in. and the fold so made is divided by small wire staples into 6 slide compartments. A second strip $1\frac{3}{4}$ wide cut off from the opposite leaf of the cover and fastened across and above the first and wired down in the same way gives six more compartments. Name, date and lesion are written at the top of the slide holder so made, and the anatomical lesion on the back of it. A filing cabinet 22 in. deep taking a card $9\frac{1}{2}$ by $7\frac{1}{2}$ in. holds 250 of these holders.

R. E. SCAMMON (*Anat. Rec.*, Feb., 1919) mounts microscopic slides on an ordinary heavy white filing card 3 by 5 in. A hole the size of the slide is cut in the middle of the slide and it is fastened in place by strips of passe-partout $\frac{3}{8}$ in. wide, cut a little longer than the slide which pass from right to left above and below it on both sides of the card. Two other strips of passe-partout are pasted completely round the card in such a way that they cover the cut ends of the horizontal passe-partout paper and the ends of the slide. A similar mount was described by ROBINSON (*Jour. Am. Med. Assoc.*, 1917, lxxi, 1379), who used a circular opening cut through the lower part of a somewhat larger card; the slide was fastened to the back of the card behind the opening. COPLIN uses a 3 by 5 in. card with a hole, the width of the slides but a little shorter, cut out of the lower border of the card. The slide is fastened in place by a sheet of white paper with a corresponding hole in its lower border and cut the same length as the card but double its depth, which folds around it from before backward, and is pasted in position on both sides in such a way that the slide is exposed through the hole in both folder and card.

M. E. A.

BOOK REVIEWS

The Microtometist's Vade-Mecum. A. B. Lee, 8th Edition, edited by J. Bronte Gatenby. P. Blakiston, Son and Co.

In this latest edition many of the chapters have been revised and even almost entirely rewritten, and the contents of the book generally brought up to date. The discussions on cytological methods and on the fatty substances with the newest advances in microchemistry are especially good. In all probability the chapters on neurological technique form the best compilation of methods and description of results published in the English language and are of great value to the neurologist and neuropathologist. With the addition of a very large number of references the book forms a complete and very stimulating book for the research worker.

EDNA DYAR.

The Blood Supply to the Heart in its Anatomical and Clinical Aspects. By Louis Gross, M.D., C.M., with an Introduction by Horst Oertel, Strathcona Professor of Pathology, McGill University. Cloth, 170 pages, with twenty-nine full page plates and six text illustrations. Published by Paul B. Hoeber, 67-69 East 59th Street, New York. Price, \$5.00.

Our present knowledge of the distribution of blood vessels is founded mainly upon investigations made on injected preparations. Before the advent of roentgen rays, workers depended upon dissection, corrosion methods and serial section to obtain a visual conception of the injected vascular system. The success or failure of the injection itself depended principally upon the skill of the technician. In the first chapter of this book, the author reviews the older methods of injection and described the one which he used in his investigations. The principal advantages of his technique of injection are

its simplicity, the possibility of preparing a series of specimens under uniform conditions, the elimination of the personal equation to a very large extent and the readiness with which a plastic picture of the injected vessels is obtained.

From a careful study of one hundred normal hearts, the author describes a theoretical average normal distribution of the coronary arteries and veins; he then analyses the variations that were found. In the fourth chapter convincing evidence is established to indicate the pressure of a "distinct and specific blood supply for both the sinu-auricular and auriculo-ventricular nodes, the main bundle and the first portion of the left limb and a large part of the right limb of the neuro-muscular system". In addition to anatomical facts well illustrated by beautiful photographic plates, facts deduced from clinical and pathological observations are brought to bear on this subject.

Of particular interest from a clinico-pathological point of view are the observations on the blood supply to the heart valves. A plausible theory is advanced to explain the pathogenesis of valvular endocarditis as a bacterial embolic phenomenon, in cases where valvular blood vessels present during infancy did not regress but persisted during childhood, adolescent or adult life. The long disputed question as to whether anastomoses do or do not exist between the right and left coronary arteries is finally settled. An examination of the effective plates and of the text leaves no doubt in the reader's mind as to the existence of anastomoses between branches of the two coronary arteries.

The last chapter is, indeed, the "*pièce de résistance*" of the book. The author himself as well as other workers in Professor Oertel's laboratories, have made extensive investigations of age-period changes in various other organs. This general subject is therefore not an entirely new one. However, the striking evidence presented for the first time by the contents of this chapter emphasize most strongly the great importance of giving proper consideration to normal physiological alterations due to ageing, in all anatomical investigations. The photographic plates in this chapter illustrate how, with almost dramatic precision, the blood supply through the right coronary diminishes with advancing age.

Each of the eight chapters contains a comprehensive historical review of the subject with which it deals, preceding the discussion of the author's own observations. The bibliography contains references to one hundred and ninety-five authors and many more articles. This important monograph represents a well-balanced scientific investigation by an author of exceptionally good ability, and is of equal value to anatomist, pathologist and clinician. The bookmaking is excellent and the text is abundantly illustrated with thirty-four very beautiful plates. The publisher, Mr. Paul Hoeber, is to be congratulated on the high standard of the work.

HAROLD N. SEGALL.

Proceedings of the Association

OBITUARIES OF INTERNATIONAL MEMBERS

[Members are invited to contribute to the accuracy and adequacy of this department by supplying the International Secretary with information from their respective Local Sections of Members recently deceased, giving if possible date of birth and death, list of appointments held and honours conferred and references to obituaries published elsewhere.]

DR. OSWALDO GONCALVES CRUZ (1872-1917)

Elected to active membership in the year 1910.

In the first part of the twentieth century Brazil was considered one of the greatest centres of yellow fever in the world. For this reason the efforts of its government to attract the collaboration of foreign capital and emigration were unsuccessful, although these latter were indispensable to the proper development of our natural riches and the peopling of more than eight and a half million square kilometers of territory.

To the endemic yellow fever which had made its home on our littoral since 1850, by great misfortune there was added the Indian plague, which in 1899 had its first victims in Santos and Rio de Janeiro, and which seemed to be excellently adapted to the poor hygienic conditions of the old capital as well as of many of the cities which it invaded.

On this account we were a nation in disrepute, and the principal port of South America, the most beautiful harbour, one of the most charming places in the world, was looked upon with horror by travellers who fled from our pest-ridden places, seeking in preference the republics of the Plate and of the Andes.

However, should we be able to extinguish these deadly centres, Brazil would become one of the most prosperous countries on the continent, as it had been shown* that tropical anæmia and

*Various foreign and Brazilian works, including those of the Instituto Oswaldo Cruz, have demonstrated the absence of anemia in individuals who live in the tropics.

other nosologic phantasies which frightened the European races from the tropics were nothing but a myth.

In truth, aside from the disrepute which weighed on us as a veritable proscription of Dante at the gates of Hades, all else was propitious to the life and happiness of the foreigner. Suffice it to consider the variety of climates, from the heat characteristic of the torrid zones to the most pleasant coolness of the southern states, and even in the equatorial regions the temperature is appreciably moderated by the trade winds, which alternate with the rainy season, or by the long mountain chains whose altitude often reaches 1,000 meters, lowering the thermometer to about zero Centigrade, even above the tropic of Capricorn. In addition to this, the fertility of the soil, the virgin forests, the waterfalls, vast pasture lands, mines of gold, diamonds, copper, coal, manganese, etc., to say nothing here of the inexhaustible deposits of iron.

However, all this opulence, all these natural benefits would be forever segregated from human intercourse if there were not someone capable of performing the miracle of our sanitary redemption.

To the honour of Brazil, the man of deeds and of science who had this glory was a Brazilian.

The activity of the sanitarian was not limited to this.

Disciple of the Pasteur Institute, where he became the perfect microbiologist, he conceived the plan of transforming into a school of experimental medicine, into a great institute, the then newly-founded laboratory of Manguinhos which had been destined exclusively to the preparation of serum and vaccine against plague. To accomplish this, his work had to be distributed among the multiple duties of his double position, and he surrounded himself with young disciples whose latent talents no other could recognize and lead to successful issue as could he.

And thus Brazil, which had been only a country of export of raw scientific materials for the foreign scientists and museums, soon took its place as an important centre of intellectual production, as was recognized in 1907 by the first Hygienic Congress and Exhibition of Berlin, which conferred on it, to general astonishment, the First Prize: the Gold Medal.

Four years later Oswaldo Cruz attained new triumphs at the International Hygienic Exposition of Dresden. Manguinhos had already produced the vaccine against symptomatic carbuncle (monopoly of the institute) with which A. Godoy had succeeded in definitely eradicating the greatest of the enzootics then existent



DR. OSWALDO G. CRUZ—1872-1917

among our herds of cattle; the interesting researches of H. Aragao on the life cycle of halteridium in the pigeon; the masterly notes on dipterology of A. Lutz and A. Neiva; the curious investigations of A. Fontes concerning the tubercle bacillus; the original helminthologic findings of G. Faria; the first efforts of the lamented G. Vianna; and, with other valuable publications, that immortal discovery of Carlos Chagas, the chosen disciple, the successor of Oswaldo Cruz, who recognized in him the highest exponent of his school.

To the discoverer of "trypanosoma cruzi" (causative agent of Chagas' disease) fell the "Schaudinn Prize", the coveted honorary prize awarded to the best work on protozoology by a cosmopolitan jury of scientists, among whom Brazil was represented by our Master.

Thereafter the institute has always followed the same victorious path. Since 1912 it has been housed in a beautiful palace in the Moorish style of architecture, in which is revealed another aspect of the many sided mind of its founder; his æsthetic soul.

The Oswaldo Cruz Institute is located on the small "fazenda" of Manguinhos, situated in the suburbs of Rio de Janeiro. It includes the following principal sections: bacteriology, protozoology, pathogenic mycology, medical entomology, physiology, physical chemistry, pathological anatomy, tropical pathology, etc.

It produces on a large scale the following preparations: serums, antipest, antitetanic, antistreptococcic, antiscorpionic, (made in the Bello Horizonte branch), etc., and various agglutinating, hemolytic and precipitating serums for serologic reactions; vaccines against plague, symptomatic carbuncle, true carbuncle, chicken spirillosis, typhoid (multivalent), staphylococcus, calf diarrhoea, etc.; crude and diluted tuberculin for diagnostic and therapeutic use; mallein; solution of tartar emetic for intravenous injections (treatment of Leishmaniosis, venereal granuloma, etc.); "protosan" (invented by A. Machado for the treatment of equine trypanosomiasis, known under the name of *mal de cadeiras*) etc.

Since 1908 it has maintained a course of microbiology and medical zoology frequented by foreign and native doctors and students who specialize in these subjects and later lend valuable services in various points in Brazil and other South American countries.

Another important means of scientific propaganda is the official journal—*Memorias do Instituto Oswaldo Cruz*—repository

of original studies carried on under the auspices of the institution. This is at present in its twelfth volume. Either in the *Memorias* or by other means of publication there have issued from the institute nearly 500 articles.

There is a large and artistic museum where almost all the scientific sections are represented, prominent being that of pathologic anatomy at present directed by Professor Bowman Corning Crowell.*

There are also notable collections of various diptera nematocera, particularly that of the culicidae; that of brachycera, with numerous tabanides; that of aphaniptera; hemiptera, especially triatomas; ixodides; helminths; snakes; bacteria; fungi, etc.

The admirable library contains about 36,000 works and receives, more or less, 700 scientific periodicals. The books and interesting articles in the journals are catalogued by the decimal system of the Bibliographic Institute of Brussels.

It has various offices and workshops: of drawing, photography (including microphotography and microcinematography), X-rays, printing, glass works, bindery, plumbing and locksmithing, carpentry, refrigerator, etc.

Near the main building is a hospital with 54 beds intended for the study of tropical diseases; and well advanced in construction is the building for the section of chemistry and official remedies.

The work of our institute is not restricted to the capital. In Maranhao and in Minas (Bello Horizonte) there are two branches, and there are persistent requests that this benefit be extended to other states and even to a neighbouring friendly country.

This, in rapid synthesis, is the spiritual life of the great man of deeds, who died at forty-four years of age full of patriotic and humanitarian ideas.

It was not, then, without a very firm basis, that, in 1907, Dr. Nicolas Senn, the brilliant American physician, urged for this man a statue of solid gold of natural size.

To our honour the day is not far distant in which a bronze monument, erected in a public park, will put in concrete form the gratitude of the Brazilian people to their immortal benefactor.

DR. EZEQUIEL CAETANO DIAS.

*This Communication was received for publication in July, 1919.—ED.

SIR MARC ARMAND RUFFER, C.M.G.

In the death of Sir Marc Armand Ruffer, the world lost a most distinguished sanitarian and Britain a noble citizen. Born of French parents in Lyons, he received his early education in France and Germany, and at Oxford University, where he graduated in medicine in 1887. His first important publication, *Cell Inclusion in Cancer* attracted wide attention and, with his subsequent work on phagocytosis and inflammation, won the ardent support of Metchnikoff. These and like researches led to his early appointment as Director of the British Institute of Preventive Medicine, and his labours at this post contributed very largely to laying the secure foundations for the Lister Institute of to-day.

In 1896 he accepted the professorship of Bacteriology in the University of Cairo, and in 1901 he became President of the Sanitary Maritime and Quarantine Council of Egypt. Under his direction numerous laboratories for the diagnosis and study of infectious diseases prevalent in Egypt were established, which contributed greatly to their prevention and control. In later life he was greatly interested in Egyptian Archæology and published a number of brilliant studies on paleopathology.* He was appointed British Red Cross Commissioner for Alexandria and the Canal Zone in May, 1915.

In April, 1917, when returning to Egypt from Greece, whither he had gone in response to a request to organize the medical services of the Greek Provisional Government, the vessel on which he sailed was torpedoed and sunk, and he met a tragic death.

Sir Marc Armand Ruffer was a remarkable organizer, and was greatly esteemed by his contemporaries and beloved by his associates. Among the many honours bestowed upon him may be mentioned the C.M.G., Grand Officer of the Osmanli, Knight Commander of the Cross of Italy, Knight Commander of the Order of St. Anne of Russia, Officer of the Legion of Honour of France.

He accepted membership in the International Association of Medical Museums on the occasion of the International Congress of Medicine at London in 1913, and was an active contributor to its exchange department.

*"On Arterial Lesions Found in Egyptian Mummies". *Jour. Path. and Bact.*, XV, 1910-11.

"On Osseous Lesions in Ancient Egyptians." *Jour. Path. and Bact.*, XVI, 1911-1912.

"Studies in Paleopathology." *Jour. Path. and Bact.*, XVIII, 1913-14

JULES COURMONT (1863-1918)

Elected to active membership in August, 1913.

Jules Courmont, born at Lyon in 1863, followed the study of his profession at the Faculty of Medicine of that city and became one of its most widely recognized and distinguished leaders.

His best known works are on the subjects of typhoid fever and tuberculosis; he also gave evidence of his tireless energy in his work as a bacteriologist and physician.

He was extremely active and was widely read in all the advances of science; he tried always to find for her practical applications. It was thus that he came to interest himself in hygiene, and also that the University of Lyon came to nominate him professor of that subject.

As much by his instruction as by his work, he contributed in a marked degree to the development of social hygiene. In conjunction with S. Arloing, he instituted at Lyon the first anti-tubercular dispensary; he was also the Director of the Institute of Bacteriology at Lyon, and organized the Museum of Hygiene at the Faculty of Medicine.

The war offered him a new field for his activities. He was appointed the Technical Director of the *Service de Santé*, for the whole division of south-west France. He organized hospitals for contagious cases and for tubercular soldiers at Lyon.

This heavy work was bound to end in premature death. Jules Courmont died suddenly in 1918, before he had the good fortune to see the Allies victorious, and his country, which he had served with such unselfishness and devotion, liberated of her enemies.

PARIS

GUSTAV ROUSSY.

ALEX. ROBERT FERGUSON (1870-1920)

Professor A. R. Ferguson graduated from the University of Glasgow with high honours in 1892, and held resident appointments thereafter at the Glasgow Western Infirmary. Woodlilce Asylum and the City Fever Hospital. In 1895 he became Assistant to the late Professor Coats and Assistant Pathologist to the Glasgow Western Infirmary and in 1905 he was appointed to the Chair of Pathology of the School of Medicine of Cairo, Egypt, and Pathologist to the hospital there. During the war he officiated as Director of the Central Laboratory for the Alexandria District

at No. 21 British General Hospital, and later as Consulting Pathologist to the troops in Egypt. In recognition of his services he was awarded the O.B.E. He succumbed to the effects of overstrain and pulmonary tuberculosis, on February 22nd, 1922.

Dr. Ferguson was the author of numerous papers on tropical medicine, and made a special study of bilharziosis. He was an ardent museum worker, and in this connection published a descriptive catalogue of the pathological museum of the Cairo School of Medicine, bound in looseleaf and arranged on the decimal system of classification, which is of great interest to all museum workers. He was an active member of the International Association of Medical Museums from its organization in 1907, until his decease, and contributed to its Experience and Exchange departments. A full obituary notice is published in the *Journal of Pathology and Bacteriology*, 1919-1920, XXIII, pages 499-502.

*For Obituary of the late Sir William Osler
see opposite Frontispiece.*

WILLIAM FISKE WHITNEY (1850-1921)

Elected an organizing member of this Association, April, 1907.

The death of Wm. F. Whitney, Curator of the Warren Anatomical Museum, from cerebral hæmorrhage on March 4th, 1921, removes from our midst one of the very few special workers we have possessed in the field of the medical museum, and another of those early pioneers in pathology and the use of the microscope on this continent of whom his contemporaries, the late Sir William Osler and Prof. Wm. Welch are notable examples.

Dr. Whitney graduated from Harvard University in 1871 and Medical School in 1875, and after post-graduate studies abroad in Berlin, Munich, Vienna and Strassburg, was appointed pathologist to the Massachusetts General Hospital in 1878, and to the charge of the Warren Museum in 1879. During his long tenure of this office he was closely associated with the development of the Harvard Medical School and was secretary of its Faculty from 1883-1889; professor of parasitology in its Veterinary School from 1891-1901, and for many years a member of its admin-

istrative body. Under his curatorship the Warren Museum passed from its original home in the old Harvard Medical School building on North Grove street in Boston to its more adequate quarters on Boylston street, and thence to its present spacious location in the front block of the Longwood avenue buildings. Throughout these difficult and changeful years, Dr. Whitney rendered distinguished service, both in safe-guarding and preserving that valuable and historical collection to posterity, and in guiding its evolution and reconstruction under modern auspices to the present composite whole.

In addition to these more academic functions, Dr. Whitney filled an important place in Boston professional life, both through his activities in local medical and scientific societies, and through the active collaboration which he constantly rendered to the surgeon and medico-legal expert by the use of rapid histological methods for the immediate establishment of pathological diagnoses in the operating room and at the bedside or at court. In this connection he published a number of articles, which are chiefly along lines of diagnostic technique.

Dr. Whitney was an active and interested member of the International Association of Medical Museums from its first organization, and he was one of its warmest supporters. He belonged to that older school of pathologists who base their observations upon the exact study of the body tissues as seen under the microscope, whom we recognize to-day under the title of Morphologist and whose field of work we are proud to claim as the peculiar province of this association. His early student and post-graduate work synchronized with that of Osler and was passed under very similar cultural influences. Time is again bringing to light the value of such earnest and quiet researches as those conducted by Dr. Whitney within the sanctum of his museum and laboratory throughout the incessant labour of his long life of medical school and hospital activity.

In an Appreciation entitled, "A Tribute to a Pioneer in Modern Pathology" by J. C. Warren, M.D., and S. J. Mixter, M.D., published in the *Boston Medical and Surgical Journal*, January 26th, 1922, we are given a sympathetic account of his life and work by those who were in a position to know and appraise their valucs.

MAUDE E. ABBOTT.



DR. WILLIAM FISKE WHITNEY—1850-1921

SIR GERMAN SIMS WOODHEAD

(January 1st, 1855-December 29th, 1921)

[Sir German Sims Woodhead was elected to membership in the International Association of Medical Museums at a meeting held in Washington in 1908, in conjunction with the International Congress of Tuberculosis. A sympathetic personal Reminiscence by him of the late Sir William Osler was one of the first contributions received to the Sir William Osler Memorial Bulletin, No. IX. It will appear posthumously in that number.—EDITOR.]

Concerning the passing of many of the leaders in a profession such as medicine the regret is purely formal. Their work is done, probably their usefulness long outlived. They are respected, looked back on as forces once active and their epitaph recorded in current literature. It is quite otherwise with a man such as German Sims Woodhead. Each one who came in contact with him whether as pupil, subordinate, colleague or friend feels to-day the blankness of a personal loss. He was not merely a great scientist and teacher, he was a man of deep conviction and strong character actuated always by a sense of duty and above all by the spirit of service of his fellow man.

The eldest son of the late Joseph Woodhead, formerly M.P. for Spen Valley, editor and proprietor of the *Huddersfield Examiner*, an ardent liberal and non-conformist, Sims Woodhead carried on the family tradition of stalwart independence of thought and action. His preliminary education was received at Huddersfield College and in 1878 he took the degree of M.B., C.M., at Edinburgh University. At the great northern medical school he was popular alike with teachers and fellow-students. For many years president of the Edinburgh University Athletic Club, he was a good short distance runner and played half at Rugby football. In later life he was a good average performer on the golf links. He studied abroad in Berlin and Vienna and was a personal friend of Rudolf Virchow, Metchnikoff, Roux, Weigert and many others of the masters of medicine on the continent of Europe. In 1881 he obtained a Gold Medal for his thesis for the M.D. degree. He acted as resident during the winter 1878-79 in the Royal Infirmary, one of his colleagues being Sir James Mackenzie, and he was selected by Professor Greenfield to serve as his assistant. It was at this time that bacteriology first came into prominence in relation to disease and Woodhead took a leading part in its introduction to a place in the medical curriculum.



SIR GERMAN SIMS WOODHEAD—1855-1921

He held the posts of Pathologist to the Sick Children's Hospital and to the Royal Infirmary, Edinburgh. In 1887 he was appointed Superintendent of the Laboratories of the Royal Colleges, Edinburgh, a post which he held till 1890 when he went to London in a similar capacity. In 1899 he was appointed to the Chair of Pathology in Cambridge University.

Probably his name will be longest and most closely associated with the *Journal of Pathology and Bacteriology*, which he founded and edited for twenty-seven years. The *Journal* has become the official organ of the Pathological Society of Great Britain and Ireland and in its January number for 1921 due acknowledgment is made of the deep debt which the contributors and readers all the world over owe to the founder.

He had many and close associations with Canada and the United States. It was the writer's privilege to accompany him on a tour through the American continent on his way to the Tuberculosis Congress at Washington, D.C., in 1908. That tour was of the nature of a triumphal progress. He was feted wherever he went. At a special convocation he received the degree of LL.D. from Toronto and everywhere acknowledgment was made of the pre-eminent position which he occupied in medicine.

While the various institutions which Woodhead directed benefited greatly by his industry and versatility it is perhaps a misfortune for science that so large a part of his time and energy was taken up with planning and organising and collecting money for his laboratories. He put himself and all he had into his schemes. The New Medical Laboratories at Cambridge, the Experimental Farm, the Cambridge Research Hospital, the Tuberculosis Colony at Papworth Hall all owe him much; but pioneer work of that kind is not done without the expenditure of heart's blood and Woodhead put all his energy into his work.

Another branch of preventive medicine also owes much to his interest and activity. Woodhead was a life long abstainer and an advocate of temperance reform. Many of his friends begged of him not to fritter away his time and energies, as they thought, on a quixotic cause run by fanatics. But Woodhead was far seeing enough to realize that temperance reform meant health to the community and strength to the State. To no part of his work did he himself attach more importance; but his manifold lecturing engagements in this and similar causes undoubtedly sapped his energies.

Like many another, Woodhead overworked himself during the years of the war. Drawn into it from the beginning owing to his association with the Territorial Force, he acted at first as

Sanitary Officer in the East Anglian District, directing his attention specially to the chlorination of water supplies, then as officer in charge of the Irish Command Depot, Tipperary, and latterly as Inspector of Laboratories in military hospitals in the United Kingdom. Much of the efficiency of the work done by the Home hospitals was due to his wide experience, his tact and energy and the saving in material and equipment which he effected. It was the writer's privilege to be inspected by him on more than one occasion. Such an inspection was not an ordeal but a pleasure of a rare kind. Personal contact with him was uplifting. Honesty, sincerity and kindness were his outstanding characteristics. As a colleague in Cambridge has well put it: "the light of his character was so radiant as perhaps to throw his attainments as a man of science into some shadow. The man outshone the accomplished scientist." Of such a man one can indeed say with Whittier:

"He has done the work of a true man
Crown him, honour him, love him,
Weep over him tears of a woman,
Stoop manliest brows above him.

No duty could overtask him
No need his will outrun
Or ever our lips could ask him
His hands the work had done."

KINGSTON, ONT.

JAMES MILLER.

PROFESSOR JOHN JOSEPH MACKENZIE

In the death of Professor Mackenzie on August 1st, of this year, the University of Toronto lost one of the most brilliant, scientific, and cultivated men of the time. Not so long ago, and even yet, the reproach is cast that Science is an enemy of the Arts. Professor Mackenzie's life is a contradiction of this. He was a keen lover of music and of good pictures, and no mean judge of good literature, with a healthy and growing distaste for the modern novel with its flashy cleverness and morbidity.

He was born in 1865 in St. Thomas, Ontario, of Scottish parents who came out to Canada in the late '50's. His early education was acquired at the St. Thomas Collegiate, whence he proceeded to the University of Toronto where he graduated in Arts in 1886, taking honours in Biology and Chemistry. His studies in Biology led him to the Universities of Berlin and Leipzig, where in the latter place he spent over two years in re-

search work. On his return to Toronto he was made a Fellow in Biology under Professor Ramsey Wright.

In 1892 he married Miss Agnes Katheleen Vesey-Rogers, of Dublin. He continued his medical studies, already begun in Leipzig, and graduated from the University of Toronto receiving the degree of M.B. in 1897. He was then appointed Bacteriologist to the Ontario Provincial Board of Health where he made an extensive study of rabies, diphtheria antitoxin, and, showing the versatility of his mind, he spent some time studying bee cultures. He was also made a lecturer in Pathology to the Royal Dental College and demonstrator in Pathology to the University of Toronto. In 1900 he relinquished his various appointments and accepted the chair in Pathology and Bacteriology of his Alma Mater, which post he held with distinction and honour till his death.

He made many valuable contributions to the literature, more particularly on the pathology of arteriosclerosis, experimental pathology of the kidney and later has done some important work on the adrenal gland. He was a member of many different societies, being one of the organizing members of this Association. He served as president of the American Association of Pathologists and Bacteriologists and the Royal Canadian Institute. He was also a member of the American Institute of Biological Chemists, the Pathological Society of Great Britain and Ireland, the Royal Society of Canada, the Society of American Bacteriologists, the Arts and Letters Club of Toronto, the York Club of Toronto, the Psi Delta Psi and the Nu Sigma Nu fraternities.

During the Great War he served overseas with No. 4 Canadian General Hospital (University of Toronto) in Salonika; later returning to England where, in the Imperial Service he worked with the late Professor Brodie, on the physical effects of chestwounds.

His brilliancy as a pathologist was largely due to the fact that he entered into his work with the broad training of a biologist as well as that of medicine, a combination not always found in pathologists especially on this continent. As a teacher he was looked up to by all. He had a very pleasing, as well as convincing way of presenting his subject. As head of his department he was a great strength on the executive. As a man he was loved and admired by all for his genial and optimistic personality. With all his intellectual qualities, however, he was simple and modest in character, with the heart of a "Gentle Scot". He had an unusual power of endearing himself to others. "He will be chief still" said one of his assistants, "for his spirit will ever remain with us."

W. L. ROBINSON.

EXPERIENCE DEPARTMENT

Members are invited to forward to this Department requests for information they may desire upon any subject that falls within the range of this Bulletin, such as Museum or Microscopic Technique, Museum Classification or arrangement, Objective Teaching Methods, etc. Enquiries will be published in due course, or, if sufficient in number, will be first issued in the form of an Experience Circular to all members, and then published, with the replies received, in the next Bulletin issued. Members are also requested to contribute information upon such subjects as they consider would be of interest to other members, as well as replies to the enquiries which are published below. Communications should be addressed to the Secretary of the Association.

COMMUNICATIONS FROM MEMBERS

- 1.—From *Miss Cecilia V. Bisson, Technician in the Neurological Laboratory of Dr. Adolf Meyer, Phipps Clinic of Psychiatry, Johns Hopkins Hospital, Baltimore, Md.*

American-made Stains:

ENQUIRY: "I have used hematoxylin crystals from the National Stain Co., in a Weigert-Pal Stain, and found them quite satisfactory. The crystals from the Harmer Laboratories have also been very good, both in cell and fibre stains. I have found it necessary in both these stains to leave the sections in stain seventy-two hours instead of forty-eight as usual for the fibre stain. I have had thionin from Leitz and the Providence Chemical Co., and found them both quite useless. We had to abandon the stain entirely and use toluidin blue instead. This also we have had from Leitz. It is not a good stain—does not give sharp, clear pictures. *I would appreciate very much any information regarding good blue stains that your members could give me.*"

REPLY: This enquiry is fully and authoritatively answered by the Committee on Bacteriological Technique in their *Reports on the Standardization of Biological Stains*, of which the first is published in the *Journ. of Bact.*, Vol. I, January, 1922, and others will appear shortly. *Editors.*

- 2.—From *Prof. J. L. Todd, Department of Parasitology, McGill University, Montreal.*

Re-Staining Old Microscopic Slides:

ENQUIRY: "During the course of various expeditions, large numbers of smears of blood and organs from men and various animals and birds were made, some of them twenty years ago. A number of them, when the difficulty of staining old slides was learned, were at once fixed in absolute alcohol. Others were not fixed. Great difficulty has been found in staining these old slides by Giemsa and other modifications of Romanowsky's method. Attempts have entirely failed for the slides that were unfixed, and have been very unsatisfactory for the slides that were fixed; on the other hand it has been found easy to re-stain, even after a lapse of many years, slides that were once successfully coloured by the modification of Romanowsky's method (that described by Christophers and Stephens) which is usually employed.

A satisfactory method of re-staining old slides would be appreciated."

Reply Requested.

- 3.—From *Miss Edna G. Dyar, Technician, St. Elizabeth Hospital, Washington, D.C.*

Microscopic Technique:

ENQUIRY: (1) Where may 4 by 6 inch glass covers for neurological sections be secured?

(2) Articles giving information about microtome knives and methods for sharpening same?

(3) What material is used for large mounting blocks (comparable to the red vulcanized fibre for small ones) for microtomes such as the Sartorius or others of similar kind for cutting large blocks?

Reply Requested.

- 4.—From *Prof. H. E. Robertson, Department of Public Health, University of Minnesota, Minneapolis.*

Difficulties Encountered in the Condensation of Museum Material:

EXPERIENCE GIVEN: "Both at the University of Minnesota and at the Mayo Clinic, the necessity for condensing the specimens in the Pathological Museum has involved the attempts at solution of numerous problems. Our efforts have been devoted chiefly towards collecting together specimens of single organs and still retaining their identity and accessibility.

This we have partially accomplished by attaching to the organs a fibre label stamped by metal type with the catalogue number of the case and enclosing groups of these specimens in small sacks made of ordinary unbleached muslin of such size that not more than ten or less than three were enclosed in a single sack. Attached to each sack was a fibre label with a list of the numbers of the specimens enclosed. In the case of very small specimens, smaller sacks were enclosed in larger ones. These were again placed in twenty gallon stoneware crocks and covered with ten per cent. formol, and the crock

given an appropriate label so that its contents might be readily catalogued.

As a method of partially sealing the crock, a strip of felt was glued to the rim of the cover, thus furnishing a fairly impermeable casket.

In this manner many specimens not suitable for display but still desirable for routine preservation or research are adequately preserved without at the same time utilizing either expensive glassware or still more expensive shelf room."

5.—From *Prof. Stuart Graves, Department of Pathology, University of Louisville, Kentucky.*

Avoiding Infection in Specimens Preserved in Kaiserling:

ENQUIRY: "We have been in the habit of storing our Kaiserling specimens immersed in the Kaiserling in black glazed butter jars with covers, and we have had great trouble with moulds and other infections. Could you tell me whether or not the specimens, after having lain a few weeks in Kaiserling III (we have used C.P. Glycerine) could be permanently preserved in Russian Oil without trouble from bacteria and parasites and possibly without the necessity of keeping them in the dark? Or is it better to drop the Kaiserling colour method and use straight 10 per cent formalin?"

REPLY: We have not had much personal experience with Russian Oil but we do not think it replaces the Kaiserling method satisfactorily. Fungi do not grow in it, but the shrinkage is considerable and in our judgment prevents the method from being satisfactory. Kaiserling III specimens can be kept satisfactorily in storage if a little thymol be added to the solution and if the specimens are preserved in glass storage jars with rubber ring and clamp top and if care is taken to avoid contamination, when opening the jar, from other infected specimens. *Glazed butter crocks should be abolished.*

McGill Pathological Museum.

DEPARTMENT OF EXCHANGES

One of the most important functions of this Association is the development of an international system of exchange of museum specimens and pathological material for microscopic research. This exchange has been conducted, up to the present time, by means of correspondence, a circular letter being sent out from time to time by the International Secretary, requesting a statement of material wanted and material offered in exchange, and the announcements received in reply being published in the succeeding Bulletin, or made in the intervals of publication by means of a printed circular. Up to the out-break of the War, the response received from foreign members had been good, and a number of important exchanges had been transacted. But the growth of the correspondence and of the American and Canadian membership has made it impossible at the present time to conduct an active international exchange without a larger organization. Moreover, it has long been the desire of the Association to extend the efficiency of its Exchange department through the establishment of a more centrally situated depot supplied with the fundamental requisites for the effective discharge of its activities, especially adequate clerical help. Through the timely action of the American Government, such arrangement has now become a *fait accompli*. For official information on this advance in the status of the Association, members are referred to the Editorial on page 15 of this issue, which is written by the Curator of the Army Medical Museum, and which informs us that this matter has had the warm interest and the support of the Surgeon-General of the U.S. Army and that the space and provision necessary for the maintenance and operation of the Exchange Department of the American and Canadian Section of this Association, is provided at the Army Medical Museum, where it is now stationed.

CONDITIONS OF EXCHANGE.

1. Requests and offers of material are to be addressed to *The Curator, Army Medical Museum, Washington, D.C.* Duplicate copies of statements so forwarded may be sent also, if desired, to the International Secretary for publication in the succeeding Bulletin. Material for exchange not exceeding four pounds in weight, forwarded to the Exchange Depot at Washington, may be franked.

2. Large anatomical specimens should not be transported in individual glass jars, but in bulk, each specimen wrapped in moist wool, and packed in soldered tin or other water-tight receptacle; very small specimens may be sent by post. Full details of the methods of packing and shipping delicate small specimens for exchange are given below under the communication from the *Wellcome Bureau for Scientific Research*.

3. Each specimen given in exchange should be tagged with its reference label and a short statement of the nature of the specimen and of the case-history should be forwarded to the recipient.

4. When exchanges are made directly between members without the intervention of the Exchange Depot, on the basis of information conveyed through the Exchange Department of the Bulletin, the cost of transportation is paid by the recipient. Before any such shipment is made, the donor should inform the recipient of his intention in case the request made in these columns has already been supplied.

EXCHANGES REPORTED

From *Prof. Dr. Carl Wegelin, Berne, Switzerland*, to the *Medical Museum, McGill University*—Specimens of diffuse and nodular colloid struma; Nodular parenchymatous struma; the same with early stages of adenoma; Metastasis of an adenoma of the thyroid in lung; Proliferative Struma of Langhans; Papilloma and carcinoma of thyroid. From *McGill University* to *Prof. Dr. Carl Wegelin*—*Planorbis guadeloupensis*; *Glanfordia nosophora*.

EXCHANGES PROPOSED

Dr. Oscar d'Utra Silva, Rio de Janeiro, Brazil.

REQUESTS: Collections of typical material for classes of general and special pathology, tumours, etc., for teaching.

OFFERS IN EXCHANGE: Histological Material from Tropical Diseases.

Prof. J. J. Ower, Department of Pathology, University of Alberta, Edmonton, Alberta. (For Immediate Use).

REQUESTS: Any specimens suitable for demonstration in a class on general pathology, including slices of organs showing thrombosis, embolism, infarction, hæmorrhage, fatty infiltration, amyloid, calcification, pigmentation, gangrene, caseation, tumours, lesions of infectious diseases, parasites, monstrosities; bone lesions, especially fractures.

Prof. J. L. Todd, Department of Parasitology, McGill University, Montreal.

REQUESTS: Leishmaniasis, cutaneous or visceral; mycetomiasis, all forms; gross specimens of tropical granulomata of pudendæ; gross specimens of tropical ulcerations; gross specimens of leprosy; microscopical and gross preparations of all newly-discovered diseases or of newly-described developmental changes of pathogenic organisms; and of anything which might be difficult to obtain for demonstration purposes in the work of a Department of Parasitology, especially in a temperate climate.

OFFERS IN EXCHANGE: Mounted microscopical preparations of wings, legs and arista of tsetse flies, all phases of *Ornithodoros moubata*.

Dr. H. W. Wade, Chief Department of Pathology and Bacteriology, College of Medicine and Surgery, Manila, P.I.

REQUESTS: Syphilis (aneurysms, gummata). Leishmania (cutaneous and visceral), Verruga peruviani, Fungous infections (blastomycosis, Gaucher's splenomegaly).

OFFERS IN EXCHANGE: Leprosy (tissues and smears), dysentery, (bacillary and amoebic); cholera, primary carcinoma of liver, splenomegaly, simple, "tropical," hæmopoietic spleen.

Prof. Dr. Carl Wegelin, Berne, Switzerland.

REQUESTS: Amoeba histolytica, Trypanosoma and Trypanosoma gambiense; Brain from Malaria tropica; Balantidium coli; Filaria sanguinis Bancrofti.

OFFERS IN EXCHANGE: Microscopic specimens of endemic goitre and malignant tumours of the thyroid.

Dr. Maude E. Abbott and Miss Eleanor Shanly, M.Sc., McGill University, Montreal.

REQUEST: Hearts of the lower orders of Vertebrates, especially ganoid and dipnoid fishes, and of all orders of reptiles, also obscure cardiac anomalies.

Wellcome Bureau of Scientific Research, 25-27 Endsleigh Gardens, Gordon Square, London, N.W.L., Dr. S. H. Daukes, O.B.E., Curator.

REQUESTS: *Biting Flies* (mosquitoes, etc.), bugs, ticks, lice, scorpions, poisonous spiders, centipedes, millipedes, biting ants and leeches; *Poisonous Snakes*, lizards, fish, molluscs, also larvivorous fish and other natural enemies of mosquito larvæ; *Blood Films*: of man in cases of malaria, trypanosomiasis, filariasis and other diseases; of sick horse, cattle, sheep, goats, dogs, (smears of spleen, liver and bone marrow wanted also in such cases); also, *Blood Films* of small mammals, birds, fish, reptiles (skates, lizards, tortoises and turtles); amphibia (frogs, toads, newts, salamanders, etc.); *Smears* from ulcers and other sores, scrapings from tropical skin diseases and diseased hairs; *Smears of faeces* in cases of dysentery, intestinal worms (round worms, tape worms, flukes) of man, domestic and other animals, also specimens of faeces preserved as directed below; *Organs* of human beings who have died of tropical diseases, large spleens and livers, dysenteric intestines, bilharzia intestines, bladders, etc., or pieces of such organs, and tumours which have been removed by operation in filariasis, elephantiasis, etc. *Photographs* illustrating diseases and pathological conditions, or native methods of treatment, diseases and hygiene in the tropics, sanitary or unsanitary conditions—methods of housing, breeding places of mosquitoes and other noxious flies; *General Information* on the above subjects; *Temperature Charts* of the course of diseases and pathological material obtained either before or after death.

GENERAL INSTRUCTIONS FOR COLLECTING PARASITES, BLOOD
FILMS, SMEARS, ETC., ISSUED BY THE WELLCOME
BUREAU OF SCIENTIFIC RESEARCH.

(A)—*Films*: *Blood Films* are most easily made by taking a small drop (three to four times the size of the head of a pin) of blood on to the end of one slide held in the right hand, and smearing it on to the surface of another slide held in the left hand. In making such films there is always a tendency to take too much rather than too little blood on to the end of the slide for smearing. In the smearing process the straight edge of the end of one slide is made to glide over the surface of the other slightly without exerting force, to press the one against the other. Directly the film is made it should be covered or placed against something with the film side down, so that any dust depositing will not settle on the blood. The slide on which the film is made must be scrupulously clean. The films should be made immediately the blood exudes from the puncture, but to prevent contamination from the skin, it is well to wipe away the first drop which exudes from the skin. Blood for films can be obtained from man by pricking the finger with a sharp needle. In the case of larger animals, such as horses, cattle, sheep, etc., the under surface of the ear can be pricked over a small vessel. From rats and mice blood can be obtained from the tip of the tail or under the surface of the ear; from birds by pricking between the scales on the toes or vessels under the wings. In the case of animals just dead, it is better to open the chest and puncture the heart. Care must be taken not to permit contamination by contact of the blood with the intestinal contents, skin or table.

In addition to making thin blood films, it is well also, if possible, to make one or two thick films. This is done by taking a comparatively large drop of blood (size of a pea) on to the middle of a slide and allowing it to dry without smearing at all. The drying of these large drops of blood may take a considerable time if the atmosphere is humid, but they are useful for the detection of larger blood parasites, such as embryos of worms.

If the blood films cannot be despatched at once, it is best to fix them by immersing for ten minutes in absolute alcohol and then allowing to dry. It is best to wrap each slide separately in tissue paper, toilet paper or ordinary writing paper.

Exact information should be given for identifying the slide, and the name of the animal from which it is obtained should be noted. Slides can be labelled by writing on the ends with liquid India-ink and a fine pen.

(B)—*Smears from Sores, Organs and Discharges*: *Smears* from organs or ulcers can be made by taking a piece of tissue and smearing the cut surface across the surface of the slide, allowing it to dry and treating it as a blood film; the base of ulcers should be first scraped and cleaned. Smears from discharges from the nose or other cavities may be made in like manner.

(C)—*Tissues*: Tissues from organs of animals which appear to be diseased can be preserved by placing them in ordinary methylated spirits (two parts spirits to one of water). This mixture should be changed several times during the course of a few days. The tissue can then be placed in the methylated spirits for sending away. A better fixative for tissues in small pieces is a saturated watery solution of corrosive sublimate (two parts) and spirit (one part). The tissue is left in this

for two days and then transferred to the dilute spirit mixture. In addition to fixing the tissues in this manner it is well also to make smear film from them as described above. Organs from tropical diseases can be preserved in spirit of formalin ten per cent. (changed once or twice). In the case of large organs it is well also to inject the fluid into the tissues.

- (D)—*Fæces*: Dried films are of little value. Fæces can be best preserved by placing a little in a test tube or small bottle (after making into an emulsion with saline) and adding about twenty times its volume in corrosive sublimate alcohol mixture (saturated water sublimate two parts, spirit one part). The tube is well shaken and a sediment allowed to form by standing vertically for some hours. The sublimate solution is then poured off and dilute spirit (spirit two parts water one part), added. It is well to pour off the spirit several times after the sediment has formed in order to wash away the superfluous sublimate. The sediment is then transferred to a small bottle which is filled up with weak spirit and securely corked for transmission. Smears of fæces can be made, but it is essential that these be not allowed to dry. The fæces are smeared on to a cover glass or slide and immediately immersed in the sublimate alcohol mixture, where it is left for about half an hour. It is then taken out and washed in weak spirit and finally placed in a glass tube in spirit and corked up in such a way that the film cannot rub off. In no case must the film be allowed to dry at any stage in the process.
- (E)—*Urine* sometimes contains parasites. A volume of urine can be mixed with about ten to twenty times its volume of sublimate mixture and the sediment which forms after standing treated as the fæces sediment described above.
- (F)—*Ecto-parasites* from animals and men (lice, fleas, bugs, ticks), can be preserved by placing them in spirit or weak formalin. If possible the various stages of development (egg, larvæ, pupæ, etc.) should be preserved. Leeches can also be preserved in the same way. The name of the host from which they have been obtained should be sent. Ticks placed in a secure cardboard box enclosed in a tin or wooden box to obviate crushing will travel through the post alive. The lid of the box (large pill box) must fit tightly.
- (G)—*Flies* which attack man or animals in order to suck their blood—the large gad or horse fly, tsetse flies, small flies, like house-flies, which suck blood (*Stomoxys*), mosquitoes of all kinds, the tiny blood-sucking midges which occur around swamps and elsewhere. The large flies can be mounted on pins, but the very small ones should be preserved by placing them in the special faced cotton wool in a pill or match box.
- (H)—*Parasite Worms* from the intestines of man or animal can be best preserved in spirit (preferably diluted two parts spirit, one part water). Large numbers of parasite worms can be obtained from the stomach and intestines of cattle, sheep, etc., killed in the slaughter houses, and worms are very common in monkeys, dogs, cats, rats. Tape worms and flukes are best preserved by placing them first in sublimate mixture (saturated water sublimate two parts, spirit one part) for twenty-four hours, and then changing to weak spirit in which they can be sent forward.

REPORTS

REPORT OF BUSINESS TRANSACTED AT THE TWELFTH, THIRTEENTH AND FOURTEENTH MEETINGS OF THE AMERICAN AND CANADIAN SECTION OF THIS ASSOCIATION

The contributions to the scientific and technical programs of these meetings are published elsewhere in this Bulletin. The following brief summary is given, for record purposes, of the main business transacted.

The *Twelfth Annual Meeting* of this Section of the Association was held at Atlantic City on June 14th, 1919. Prof. O. Klotz in the Chair. The following officers were elected for the ensuing year:

President, O. Klotz, Pittsburgh, Pa.; *First Vice-President*, W. M. L. Coplin, Philadelphia, Pa.; *Second Vice-President*, H. E. Robertson, Minneapolis, Minn.; *Third Vice-President*, H. T. Karsner, Cleveland, Ohio. *Councillors*: A. S. Warthin, Ann Arbor, Mich.; M. C. Winternitz, New Haven, Conn.; R. A. Lambert, New York; R. M. Pearce, Philadelphia, Pa.; C. F. Silvester, Washington, D.C.; J. Ewing, New York; W. G. MacCallum, Baltimore, Md.; *Secretary-Treasurer*, Maude E. Abbott, Montreal; *Assistant Secretaries*, Louis Gross and Eleanor Shanly, Montreal.

A report was presented upon the Special War Bulletin of the Association which was issued on June 30th, 1918, and contained in addition to the proceedings from the meetings of 1917 and 1918, an important retrospect of War Literature edited by Drs. A. S. Warthin and Carl V. Weller. A *Resolution* of appreciation was passed. On the recommendation of Prof. R. M. Pearce, it was *Resolved* to invite those members of the Association resident in South America to form themselves into a Local South American Section. A symposium was held on the problem of the source of supply for American-made square glass museum jars, and it was *Resolved* that every effort be made to further the development of the American manufacture of these jars and all other scientific supplies.

The *Thirteenth Annual Meeting* of this Section of the Association was held at the Department of Pathology, Cornell University Medical College, New York, on April 1st, 1920, Prof. O. Klotz in the chair. Prof. W. T. Councilman was made an Honorary Member of the Society. The following officers were elected for the ensuing year: *President*, Prof. W. M. L. Coplin, Philadelphia, Pa.; *First Vice-President*, Prof. James Ewing, New York; *Second Vice-President*, Prof. Howard Karsner, Cleveland, Ohio; *Third Vice-President*, Prof. H. E. Robertson, Minneapolis, Minn. *Councillors*: A. S. Warthin, Ann Arbor, Mich.; O. Klotz, Pittsburgh, Pa.; R. A. Lambert, New Haven, Conn.; Capt. C. F. Silvester, Washington, D.C.; W. G. MacCallum, Baltimore, Md.; L. J. Rhea, Montreal, Que.; *Secretary-Treasurer*, Maude E. Abbott, Montreal; *Assistant Secretaries*, L. Gross, Montreal; H. Goldblatt, Cleveland.

A symposium was held upon the late Sir William Osler, whose death on December 29th, 1919, had removed from the Association one of its warmest friends and benefactors. As a result of the ensuing discussion it was *Resolved* that the next Bulletin of this Association be issued as a special Osler Memorial Number. A report was presented from Council stating that the funds of the Association were not sufficient to support it in the discharge of its full activities, annual meeting and exhibits, International correspondence and Exchange, publication of its Bulletins and operation of its Central Bureau for results of research, and recommending that an appeal be made for funds for these purposes. A *Resolution* was accordingly passed, authorizing the Council to approach foundations or individuals having the disposal of funds for the furtherance of scientific work and to endeavour to obtain (a) a grant of money for the immediate publication of a suitable Osler Memorial Bulletin and for the republication of Bulletins I, II and III as already resolved; and (b) an increase of the endowment fund for the adequate permanent discharge of the full activities of this Association.

The *Fourteenth Annual Meeting* of this Section was held at Cleveland, Ohio, on March 24th, 1921. Prof. James Ewing in the Chair. The following officers were elected for the year 1921-22: *President*, James Ewing, New York; *First Vice-President*, Howard T. Karsner, New York; *Second Vice-President*, H. E. Robertson, Minneapolis; *Third Vice-President*, Major G. R. Callender, Washington, D.C.; *Councillors*, A. S. Warthin, Ann Arbor, Mich.; Oscar Klotz, San Paulo, Brazil; W. M. L.

Coplin, Philadelphia; W. G. MacCallum, Johns-Hopkins Hospital; L. J. Rhea, Montreal; F. B. Mallory, Boston; William Boyd, Winnipeg; *Secretary-Treasurer*, Maude E. Abbott, Montreal; *Assistant Secretaries*, W. W. Beattie and H. N. Segall, Montreal.

A *Resolution* of regret was passed upon the illness of the President, Prof. W. M. L. Coplin, whose influence and energies had been one of the Association's chief sources of strength since its organization.

The Secretary reported the promise of \$500.00 from the National Research Council of Washington towards the publication of the Sir William Osler Memorial Bulletin (Nos. VIII and IX), conditional on the balance required for publication being obtained. An invitation was received from the Surgeon-General of the U. S. Army through Major G. R. Callender, Curator, to hold the next Annual Meeting at the Army Medical Museum, Washington, D.C., and was accepted with thanks.

REPORT OF FIFTEENTH ANNUAL MEETING OF THE AMERICAN AND CANADIAN SECTION OF THE INTERNATIONAL ASSOCIATION OF MEDICAL MUSEUMS

The Fifteenth Annual Meeting of this Section of the Association was held at the Army Medical Museum, Washington, D.C., Monday, May 1st, 1922. The attendance was large, and included representatives of the Medical Service of the American and Canadian Governments. The Chair was occupied by the retiring President, Prof. James Ewing.

The following officers were elected for the ensuing year:

President, F. B. Mallory, Boston; *First Vice-President*, H. T. Karsner, Cleveland, Ohio; *Second Vice-President*, H. Marshall, Virginia; *Third Vice-President*, R. A. Lambert, Yale; *Secretary-Treasurer*, Maude E. Abbott, McGill University, Montreal; *Assistant Secretaries*, Harold N. Segall, Boston; and W. W. Beattie, Montreal.

Councillors: A. S. Warthin, Ann Arbor, Mich.; James Ewing, New York; W. T. Coplin, Philadelphia; Pa.; W. G. MacCallum, Baltimore, Md.; William Boyd, Winnipeg, Man.; H. E. Robertson, Mayo Clinic, Rochester, Minn.; Major James P. Coupal, Washington, D.C.; H. S. Haythorne, Pittsburgh, Pa.; Carl V. Weller, Ann Arbor, Mich.; Stuart Graves, Louisville,

Ky.; Major G. R. Callender, Manila, P.I.; L. J. Rhea, Montreal, Que.

The Secretary-Treasurer reported that sufficient funds had now been raised to proceed with the publication of the two Special Sir William Osler Memorial Bulletins.

Bulletin VIII (*Journal of Technical Methods*) and Bulletin IX (Special Osler Memorial Number) were therefore ordered published and distributed without delay.

Upon recommendation of the Council, the Exchange Bureau and the Bureau for the Preservation of the Results of Medical Research of this Section of the International Association of Medical Museums were transferred from the McGill University Medical Museum at Montreal, Canada, to the United States Army Medical Museum, Washington, D.C.

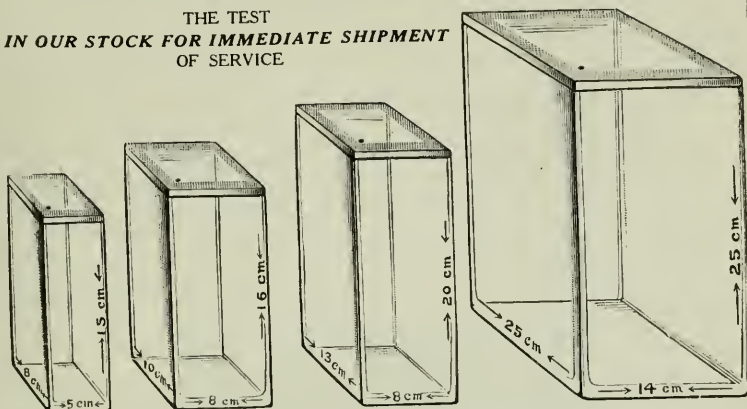
An interesting feature of the afternoon session was the presentation of the testimonial from the Medical Department of the U. S. Army to Dr. Daniel Smith Lamb, Assistant and Pathologist at the Army Medical Museum from 1865-1920. The presentation was made by Brigadier-General Walter D. MacCaw, Assistant Surgeon-General, who in a brief address, outlined the work of Dr. Lamb, and called attention to the results of his labors as illustrated by the collection of the institution in which the meeting was being held.

The following Scientific Programme was presented:

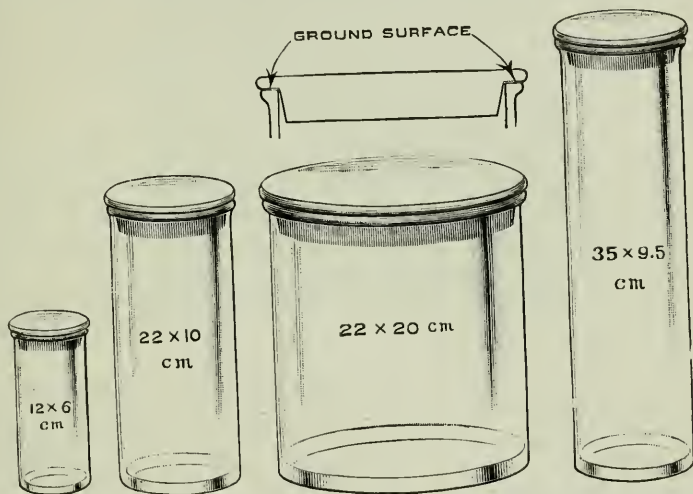
1. Traumatic Erosion of an Anomalous Right Subclavian Artery through the Posterior Wall of the Oesophagus. *Helen M. Scoville, New Haven, Conn.*
2. Intrapericardial Rupture of Aortic Aneurysm in a Boy of Sixteen Years. *De Wayne G. Richey, Pittsburgh, Pa.*
3. Discussion on So-called Spontaneous Rupture of Ascending Aorta. Illustrated by Specimens from the *Pathological Museum of McGill University.*
4. Unusual Cardiac and Cerebral Metastases of Melanotic Sarcoma. *Carl V. Weller, Ann Arbor, Mich.*
5. Multiple Cardiac Defects with Pulmonary Artery becoming Descending Aorta. *Robert A. Lambert, New Haven, Conn.*
6. Cardiac Anomaly; Mirror Picture Dextrocardia in Situs Inversus; Pulmonary Atresia. Transposition of Arterial Trunks, Oesophagus Atresia and Communicating with Trachea. *P. G. Woolley, Detroit, Mich., and W. W. Beattie, Montreal, Que.*
7. Two Primary Neoplasms of the Heart. *R. A. Lambert and Tadayoshi Tamura, New Haven, Conn.*
8. Series of Seventeen Cases of Acute and Subacute Liver Atrophy, with Special Reference to Classification and Nomenclature of the Disease. *James Miller, Kingston, Ont.*
9. The use of Antiseptics in Museum Fluids. *Samuel Hirschfeld, New Haven, Conn.*
10. Combination of Photography and Drawing in Medical Illustration. *R. A. Lambert and A. B. Hemberger, New Haven, Conn.*
11. Personal Method of Preparing Colored Photographs with Illustrative Material. *E. J. Williams, Montreal, Que.*
12. Demonstration of Rabbits, subjects of Professor Guy's Experiments

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13 Special Case Reports on Specimens of Interest in the U. S. Army Medical Museum. Presented by the *Curator and Staff*, Majors G. R. Callender, T. H. Bitterman and James Coupal, Washington, D.C.

14. The Descriptive Catalogue of the Canadian Army Medical Museum. *Maude E. Abbott, Montreal, Que.*

Presented by permission of the *D.G.M.S. Canadians*, and *Major-General J. T. Fotheringham*, Editor-in-Chief of the Catalogue. *Illustrated by* Exhibits from the Sections of: Blood Transfusion in the Forward Area, *N. B. Guio, Ottawa*; Cranial Injuries, *G. E. Wilson, Toronto*; Traumatic Lesions of Fundus of Eye, *H. E. McKee, Montreal*; Chest Medicine, *N. B. Gwyn, Toronto*; Renal Medicine, *C. F. Martin and D. S. Lewis, Montreal*; Orthopaedic Surgery, *C. L. Starr and R. I. Harris, Toronto*; Diseases and Injuries of Bone, *L. J. Rhea, Montreal*; Moist Specimens, *F. B. Gurd, Montreal*, Illustrated by Photographic Enlargements colored by *E. J. Williams, Montreal*; Field Sanitation Emergency Models, *R. St. J. MacDonald, Montreal*.

15. Methods of Preparing Colored Lantern Slides. *R. A. Lambert, B. Hemberger and F. Jewel, New Haven, Conn.*

16. On the Experimental Teaching of Pathology. *H. G. Weiskotton, Syracuse, N.Y.*

17. A Reconstruction Course in the Functioning Anatomy of the Nervous System rendering the Facts of Neuro-Anatomy readily available for Clinical, Pathological and Experimental Use. *Adolf Meyer and Louis Hausman, Baltimore, Md.*

18. Injection Technique of Gross as applied to the Reconstruction of the Blood and Bile Vessels of the Liver. *Harold N. Segall, Montreal.*

19. Demonstration of Silver Staining of Spirochetes in Cover Glass Smears. *A. S. Warthin, Ann Arbor, Mich.*

20. Special Stain for Nerve Tissue. *He'enor Campbell, Washington, D.C.*

21. Description of a New Microtome. *W. G. MacCallum, Baltimore, Md.*

22. An Apparatus for Use in Staining Blood Films. *L. J. Rhea, Montreal.*

23. Micro-cataphoresis Chamber for the Study of the Migration of Bacteria in an Electric Field. *Stuart Mudd, Boston, Mass.*

24. Microscopic Preparations from a Fatal Case of Asthma. *James Miller, Kingston, Ont.*

25. Study of a Case of Welch's Syndrome. *Winifred Blampin, Montreal.*

26. Cardiac Anomaly: Persistent Left Duct of Cuvier. Auricular and Ventricular Septal Defects. Fused Aortic Cusps and Aplasic Left Chambers. *Harold N. Segall, Montreal, Que.*

The *Annual Exhibition* of the Association, comprising exhibits from members of the American Association of Pathologists and Bacteriologists and its conjoint societies and the Canadian Army Medical Museum, was set up in the spacious halls of the Army Medical Museum, and together with exhibits from the International Congress of Ophthalmologists, and the large recent accessions of the Army Medical Museum, made an imposing and interesting display.

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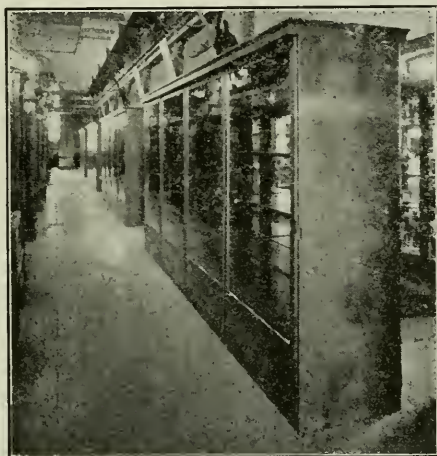
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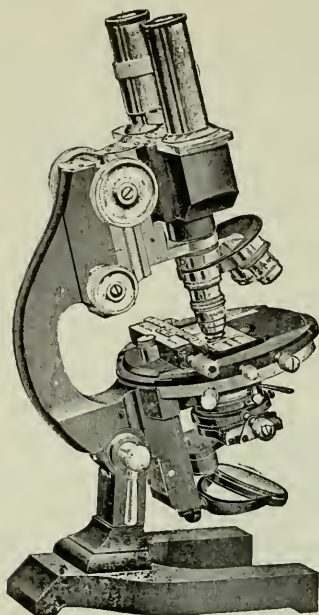
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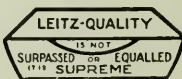
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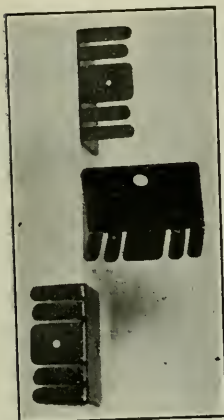
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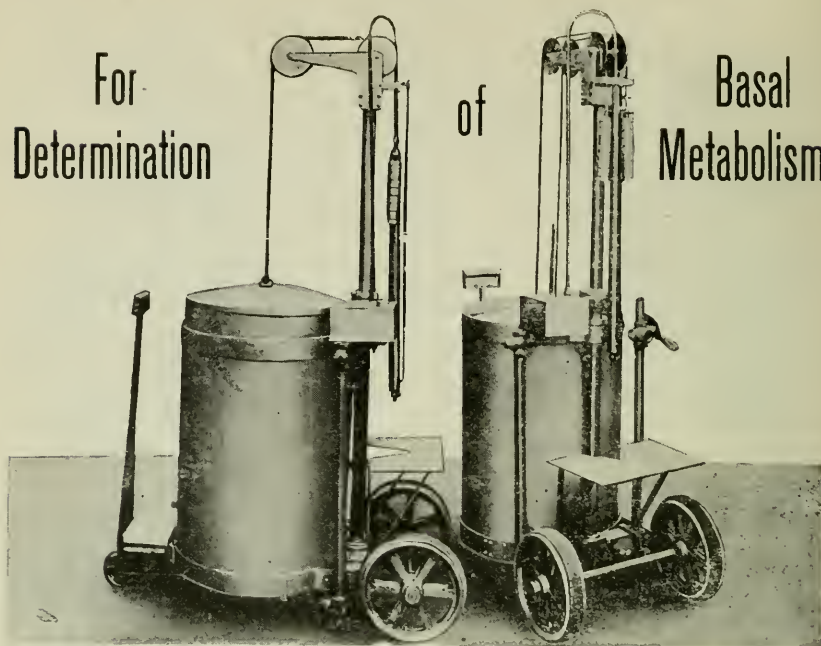
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